PROPOSED

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR CHLORINATED ALIPHATICS PRODUCTION WASTES - K173, K174, K175

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EXECUTIVE SUMMARY

This background document provides EPA's rationale and technical support for developing Land Disposal Restriction (LDR) treatment standards for K173, K174 and K175. EPA is proposing to list K173, K174, and K175 as hazardous wastes:

- K173: Wastewaters from the production of chlorinated aliphatic hydrocarbons, except wastewaters generated from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process. This listing includes wastewaters from the production of chlorinated aliphatic hydrocarbons having carbon chain lengths ranging from one to and including five, with varying amounts and positions of chlorine substitution.

- K174: Wastewater treatment sludges from the production of ethylene dichloride or vinyl chloride monomer (including sludges that result from commingled ethylene dichloride or vinyl chloride monomer wastewater and other wastewater), unless the sludges meet the following conditions: (i) they are disposed of in a Subtitle C or D landfill licensed or permitted by the state or federal government; (ii) they are not otherwise placed on the land prior to final disposal; and (iii) the generator maintains documentation demonstrating that the waste was either disposed of in an on-site landfill or consigned to a transporter or disposal facility that provided a written commitment to dispose of the waste in an off-site landfill. Respondents in any action brought to enforce the requirements of Subtitle C must, upon a showing by the government that the respondent managed wastewater treatment sludges from the production of vinyl chloride monomer or ethylene dichloride, demonstrate that they meet the terms of the exclusion set forth above. In doing so, they must provide appropriate documentation (*e.g.*, contracts between the generator and the landfill owner/operator, invoices documenting delivery of waste to landfill, etc.) that the terms of the exclusion were met.

- K175:

  Option 1: Wastewater treatment sludges from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process.

  Option 2: Wastewater treatment sludges from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process, unless i) the sludges are disposed in a Subtitle C landfill, and ii) the sludges do not fail the toxicity characteristic for mercury in 40 CFR 261.24, and iii) the generator maintains documentation demonstrating that the waste was disposed of in a Subtitle C landfill or consigned to a transporter or disposal facility that provided a written commitment to dispose of the waste in a Subtitle C landfill.

> Respondents in any action brought to enforce the requirements of Subtitle C must, upon a showing by the government that the respondent managed wastewater treatment sludges from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process, demonstrate that they meet the terms of the exclusion set forth above. In doing so, they must provide appropriate documentation (*e.g.*, contracts between the generator and the landfill owner/operator, invoices documenting delivery of waste to landfill, analytical results or other information showing the waste does not fail the toxicity characteristic for mercury, etc.) that the terms of the exclusion were met.

EPA is prohibiting the land disposal of both nonwastewater and wastewater forms of Hazardous Waste K173, K174, and K175 and proposing LDR treatment standards for these wastes. Specifically, EPA is proposing to apply existing Universal Treatment Standards found at 40 CFR 268.48 to the regulated hazardous constituents of concern in the wastes proposed to be listed as K173 and K174. Where universal treatment standards do not exist, EPA is proposing waste-specific standards for these constituents, and is proposing to add these constituents to the universal treatment standards list and the treatment standard for F039 which lists constituents of concern in multi-source leachate from landfills. In addition, EPA is proposing to apply technology-specific standards to wastes that are listed as K175. The treatment standard requires roasting or retorting of mercury (RMERC). Although the mercury in K175 would be recovered, mercury and other constituents may remain in the residuals. EPA is proposing that the residuals meet a numerical standard for mercury and pH level prior to disposal.

Characterization of Wastes

Information for this BDAT analysis was derived from answers received from a questionnaire under the authority of RCRA §3007, direct contact (via telephone or letters) with selected facilities, and a series of engineering site visits. After collecting this information, EPA studied the specific characteristics of the waste and how these wastes will be categorized in LDR treatment standards.

For K173, EPA found that the waste material was typically liquid in nature, but did not

necessarily meet the definition of "wastewater" under 40 CFR 268.2(f). To meet the definition of wastewater, wastes must have less than one percent total suspended solids (TSS) and less than one percent total organic carbon (TOC). Analysis of K173 wastes showed that the TSS content ranged up to 1.6 percent and the TOC content ranged up to 0.16. Therefore, K173 wastes may vary in wastewater determinations.

K174 and K175 are both wastewater treatment sludge, and they will typically be designated as nonwastewaters due to significant TSS and TOC content. It will be rare that generators or treatment facilities will handle these wastes in a wastewater form. EPA also found that the low BTU values of K174 and K175 and the high oil and grease content in K175 may affect the efficiency of some treatment systems. Additionally, EPA found K175 to have elevated concentrations of mercury in the sulfide form, which makes mercury recovery more difficult in roasting and retorting treatment, and leaches more easily under alkaline conditions when disposed in a landfill.

Development of BDAT Treatment Standards

In developing the LDR treatment standards proposed today, EPA adhered to the following methodology. EPA first identified the hazardous constituents present in the wastes which require treatment. EPA identified constituents proposed as the basis for listing for these wastes. Five of the constituents of concern were not on the UTS list, but EPA found that treatment of these constituents was critical to proper treatment of the waste. These five constituents were dioxin and furan congeners, *1,2,3,4,6,7,8*-heptachlorodibenzo-*p*-dioxin, *1,2,3,4,6,7,8*-heptachlorodibenzofuran, *1,2,3,4,7,8,9*-heptachlorodibenzofuran, *1,2,3,4,6,7,8,9*-octachlorodibenzo-*p*-dioxin, and *1,2,3,4,6,7,8,9*-octachlorodibenzofuran. EPA evaluated potential BDAT based on the properties of these individual compounds and existing treatment data as available, and EPA is today proposing to add these constituents to the UTS table, as well as the F039 listing for leachate from landfills.

Additionally, EPA used the record sampling data collected during the engineering site

visits and raw material and products usage. EPA compared these waste concentrations to previously investigated performance data for many of these constituents, obtained through its development of universal treatment standards (UTS) at 40 CFR §268.48 as well as its development of treatment standards for "U and P" listed wastes at 40 CFR §268.40. EPA found seven additional constituents in K173 included in the list of Universal Treatment Standards (UTS) at 40 CFR 268.48 above the given numerical levels. In K174, no additional constituents were so identified and in K175, zinc was the only additional constituent so identified. EPA did not propose a treatment standard for zinc, because it is not an underlying hazardous constituent as currently defined in 40 CFR 268.2. EPA is proposing treatment standards for all constituents (except zinc) so identified.

EPA identified pentachlorophenol in K173 and arsenic in K174 in wastes with levels below their UTS; EPA is proposing treatment standards for these constituents to ensure adequate treatment. For all remaining constituents, with and without existing UTS, EPA is not proposing treatment standards. Please see Table ES-1 for a full listing of the constituents of concern and their corresponding proposed treatment standard.

EPA believes it is appropriate to propose numerical treatment standards for the wastewater and nonwastewater forms of K173 and K174. In developing treatment standards, EPA must promulgate regulations specifying those levels or methods of treatment which substantially diminish the toxicity of the waste [RCRA §3004(m)]. In comparing these proposed numerical treatment standards to the concentrations expected to be present in K173 and K174, EPA found that the numerical standards are lower than the concentration expected to be present in the waste, in many cases, which would likely ensure that treatment occurs.

For the mercury constituent in K175, however, EPA found that while the UTS level for mercury would be lower than the proposed risk-based concentration levels, many types of treatment that could be used to meet that standards were found to be unacceptable from an environmental and human health perspective. EPA instead determined that the waste profile for this listing is similar to wastes that are currently deemed to be characteristically hazardous under

the D009 waste code. Current regulations for similar D009 wastes require either retorting or roasting (RMERC) or incineration units operated in accordance with Subtitle C regulations (IMERC). However, EPA found that the resulting mercury emissions from combustion units under IMERC would be unacceptable. Therefore, EPA is proposing that treatment of mercury in K175 be limited to roasting or retorting (RMERC). For residues of the RMERC process, EPA proposes to adopt the current standard of 0.20 mg/L TCLP mercury. EPA is alternatively proposing a numerical treatment standard of 0.025 mg/L TCLP mercury, provided that 1) the waste residue generated, if in mercuric sulfide form, must itself be below pH 6.0, and 2) if K175 wastes are to be co-disposed in a landfill with other wastes, co-disposal will be restricted to wastes with similar pH (i.e., not greater than 6.0).

The treatment standards proposed for wastewater forms of K175 and for all but five of the chemicals in the K173 and K174 wastes are consistent with the UTS limits published in the Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Treatment Standards Volume A: Universal Treatment Standards for Wastewater Forms of Listed Hazardous Wastes (July 1994) and Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Treatment Standards Volume B: Universal Treatment Standards for Wastewater Forms of Listed Hazardous Wastes (July 1994). The treatment standards for the remaining five dioxin and furan congeners were developed consistent with existing EPA procedures detailed in Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology (October, 1991). For nonwastewater forms of K175, EPA is proposing technology specific standards in conjunction with numerical treatment standards.

The universal treatment standards promulgated for each regulated organic constituent in nonwastewater forms of K173 and K174 are based on incineration treatment performance data that were used to promulgate previous BDAT treatment standards. The universal treatment standards for wastewater forms of K173, K174 and K175 are based on treatment performance data from several sources, as identified in the above mentioned 1994 BDAT Background Document for UTS. These sources include the BDAT data base, the National Pollutant

Discharge Elimination System (NPDES) data base, the Water Engineering Research Laboratory (WERL) data base, EPA-collected Wet Air Oxidation/ Powdered Activated Carbon (WAO/PACT®) data, and the EPA Office of Water's Engineering and Analysis Division (EAD) data base.

Table ES-1. Summary of Risk-Based Concentrations and Possible Numerical Treatment Standards for Constituents in Chlorinated Aliphatic Waste Streams Proposed for Listing		
Constituent of Concern	**Possible Numerical Standard (40 CFR §268)**	
	WW (mg/L)	**NWW (mg/kg)**
K173		
Bis(2-chloroethyl)ether	0.033	0.033
Chloroform	0.046	0.046
Pentachlorophenol	0.089	0.089
Phenol	0.039	0.039
2,4,6-Trichlorophenol	0.035	0.035
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin (1,2,3,4,6,7,8-HpCDD)	0.000035	0.0025
1,2,3,4,6,7,8- Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	0.000035	0.0025
1,2, 3,4,7,8,9-Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)	0.000035	0.0025
HxCDDs (All Hexachlorodibenzo-*p*-dioxins)	0.000063	0.001
HxCDFs (All Hexachlorodibenzofurans)	0.000063	0.001
1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin (OCDD)	0.000063	0.005
1,2,3,4,6,7,8,9- Octachlorodibenzofuran (OCDF)	0.000063	0.005
PeCDDs (All Pentachlorodibenzo-*p*-dioxins)	0.000063	0.001
PeCDFs (All Pentachlorodibenzofurans)	0.000035	0.001
TCDDs (All tetrachlorodi-benzo-*p*-dioxins)	0.000063	0.001
TCDFs (All tetrachlorodibenzofurans)	0.000063	0.001
Chromium (Total)	2.77	0.86 mg/L TCLP
Nickel	3.98	5.0 mg/L TCLP
K174		
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin (1,2,3,4,6,7,8-HpCDD)	0.000035	0.0025
1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	0.000035	0.0025
1,2,3,4,7,8,9- Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)	0.000035	0.0025
HxCDDs (All Hexachlorodibenzo-*p*-dioxins)	0.000063	0.001
HxCDFs (All Hexachlorodibenzofurans)	0.000063	0.001

Table ES-1. Summary of Risk-Based Concentrations and Possible Numerical Treatment Standards for Constituents in Chlorinated Aliphatic Waste Streams Proposed for Listing		
Constituent of Concern	**Possible Numerical Standard (40 CFR §268)**	
	WW (mg/L)	**NWW (mg/kg)**
1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin (OCDD)	0.000063	0.005
1,2,3,4,6,7,8,9- Octachlorodibenzofuran (OCDF)	0.000063	0.005
PeCDDs (All Pentachlorodibenzo-*p*-dioxins)	0.000063	0.001
PeCDFs (All Pentachlorodibenzofurans)	0.000035	0.001
TCDDs (All tetrachlorodi-benzo-*p*-dioxins)	0.000063	0.001
TCDFs (All tetrachlorodibenzofurans)	0.000063	0.001
Arsenic	1.4	5.0 mg/L TCLP
K175 (wastewater treatment sludge from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process) nonwastewaters that contain greater than or equal to 260 mg/kg total mercury.		
Mercury	NA	RMERC
K175 nonwastewaters that contain less than 260 mg/kg total mercury that are residues from RMERC.		
Mercury	NA	0.20 mg/L TCLP
Other K175 nonwastewaters that contain less than 260 mg/kg total mercury and are not residues from RMERC.		
Mercury	NA	0.025 mg/L TCLP
pH	NA	pH <6.0
All K175 wastewaters		
Mercury	0.15	NA

1.0 INTRODUCTION

RCRA Section 3004(m) specifies that treatment standards must minimize long- and short-term threats to human health and the environment arising from land disposal of hazardous wastes. EPA's general approach for complying with this requirement was promulgated as part of the November 7, 1986 Solvents and Dioxins rule. More recently, EPA has presented its guidance in establishing treatment standards in the Final Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology, October 1991.

EPA's treatment standards for individual wastes are presented at 40 CFR 268.40. For a given waste, a treatment standard specifies (1) the concentration of each constituent in total or TCLP analysis, or (2) a technology which must be used for treating the waste. EPA establishes treatment standards for wastewaters and nonwastewaters, as well as any subgroups which may be appropriate (e.g., "high mercury" or "low mercury" categories for D009 wastes). EPA has also established universal treatment standards for underlying hazardous constituents; these are listed at 40 CFR 268.48.

The U.S. Environmental Protection Agency (EPA) is proposing Land Disposal Restriction (LDR) treatment standards based the Best Demonstrated Available Technology (BDAT) for the regulation of listed hazardous wastes proposed to be identified in Title 40, Code of Federal Regulations, Section 261.32 (40 CFR 261.32) as K173, K174 and K175. These BDAT treatment standards are being proposed in accordance with the amendments to the Resource Conservation and Recovery Act (RCRA) of 1976 enacted by the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984. HSWA amended RCRA to require EPA to promulgate treatment standards for a waste within 6 months after determining it is hazardous [Section 3004(g)(4)].

Compliance with the proposed treatment standards is a prerequisite for land disposal, as defined in 40 CFR Part 268. In 40 CFR 268.44, EPA supplies provisions, that, if met, may justify granting a variance from the applicable treatment standards. In 40 CFR 268.6, EPA supplies provisions, that, if met, may justify granting waste- and site-specific waivers from the applicable

treatment standards in 268.40.

The proposed Hazardous Wastes Numbers K173, 174, and K175 are generated during production of chlorinate aliphatic hydrocarbons and during the production of ethylene dichloride or vinyl chloride monomer. These hazardous wastes are proposed to be defined as follows:

- K173 - Wastewaters from the production of chlorinated aliphatic hydrocarbons, except wastewaters generated from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process. This listing includes wastewaters from the production of chlorinated aliphatic hydrocarbons having carbon chain lengths ranging from one to and including five, with varying amounts and positions of chlorine substitution.

- K174 - Wastewater treatment sludges from the production of ethylene dichloride or vinyl chloride monomer (including sludges that result from commingled ethylene dichloride or vinyl chloride monomer wastewater and other wastewater), unless the sludges meet the following conditions: (i) they are disposed of in a Subtitle C or D landfill licensed or permitted by the state or federal government; (ii) they are not otherwise placed on the land prior to final disposal; and (iii) the generator maintains documentation demonstrating that the waste was either disposed of in an on-site landfill or consigned to a transporter or disposal facility that provided a written commitment to dispose of the waste in an off-site landfill. Respondents in any action brought to enforce the requirements of Subtitle C must, upon a showing by the government that the respondent managed wastewater treatment sludges from the production of vinyl chloride monomer or ethylene dichloride, demonstrate that they meet the terms of the exclusion set forth above. In doing so, they must provide appropriate documentation (*e.g.*, contracts between the generator and the landfill owner/operator, invoices documenting delivery of waste to landfill, etc.) that the terms of the exclusion were met.

- K175 -
  Option 1: Wastewater treatment sludges from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process.

  Option 2: Wastewater treatment sludges from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process, unless i) the sludges are disposed in a Subtitle C landfill, and ii) the sludges do not fail the toxicity characteristic for mercury in 40 CFR 261.24, and iii) the generator maintains documentation demonstrating that the waste was disposed of in a Subtitle C landfill or consigned to a transporter or disposal facility that provided a written commitment to dispose of the waste in a Subtitle C landfill. Respondents in any action brought to enforce the requirements of Subtitle C must, upon a

showing by the government that the respondent managed wastewater treatment sludges from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process, demonstrate that they meet the terms of the exclusion set forth above. In doing so, they must provide appropriate documentation (*e.g.*, contracts between the generator and the landfill owner/operator, invoices documenting delivery of waste to landfill, analytical results or other information showing the waste does not fail the toxicity characteristic for mercury, etc.) that the terms of the exclusion were met.

This background document provides EPA's rationale and technical support for developing LDR treatment standards for K173, K174, and K175.

1.1 Regulatory Background

Section 3001(e)(2) of RCRA requires EPA to determine whether to list as hazardous, wastes from the production of chlorinated aliphatics. In June of 1991, EPA entered into a proposed consent decree in a lawsuit filed by the Environmental Defense Fund, et al. (EDF v. Reilly, Civ. No. 89-0598 (D.D.C.), hereafter referred to as the consent decree). The consent decree sets out a series of deadlines for promulgating RCRA listing decisions, including a requirement propose a hazardous waste listing determination for wastewaters and wastewater treatment sludges generated from the production of specified chlorinated aliphatic chemicals. The wastewater and wastewater treatment sludges subject to the consent decree are those from the production of chlorinated aliphatics for which other process wastes already have been designated as hazardous waste F024 in 40 CFR 261.31. According to the consent decree, EPA must propose listing determinations by July 30, 1999 and promulgate final listing determinations on or before September 30, 2000. Today EPA is proposing listing determinations for these wastes in accordance with the consent decree.

In the past, EPA has proposed and finalized 11 different listed wastes from the production of chlorinated aliphatics. In addition, LDR treatment standards have been promulgated for these wastestreams. This background document does not affect the scope of the chlorinated aliphatics process wastes that already have been listed as hazardous in prior EPA rulemakings.

EPA's investigation of the wastes generated by the chlorinated aliphatics industry has been underway since 1992 and can be characterized in terms of two major information collection efforts: field investigations and survey evaluation. EPA's field investigations included engineering site visits, "familiarization sampling" (sample collection and analysis to gain a preliminary understanding of the nature and concentration of potential constituents of concern), and "record sampling" (sample collection and analysis to provide data to use in assessing the potential risks posed by the wastes). The survey effort included the development, distribution, and assessment of an extensive industry-wide RCRA Section 3007 survey.

1.2 Summary

The LDR program is designed to protect human health and the environment by prohibiting the land disposal of RCRA hazardous wastes unless specific treatment standards are met. In RCRA Section 3004(m), Congress directed EPA to: ". . . promulgate . . . levels or methods of treatment . . . which substantially diminish the toxicity of the waste or . . . the likelihood of migration of hazardous constituents . . . so that short-term and long-term threats to human health and the environment are minimized." Key provisions of the LDR program require that: (1) treatment standards are met prior to land disposal, (2) treatment is not evaded by long-term storage, (3) actual treatment occurs rather than dilution, (4) record keeping and tracking follow a waste from "cradle to grave" (i.e., generation to disposal), and (5) certification verifies that the specified treatment standards have been met.

In developing the LDR treatment standards proposed today, EPA adhered to the following methodology. EPA first identified the Best Demonstrated Available Technology (BDAT) for the hazardous constituents present in the wastes. In identifying hazardous constituents, EPA considered the constituents that comprise the basis of the proposed listings and also identified the presence of those other constituents near or in excess of current numerical universal treatment standards. EPA has previously investigated performance data for many of these constituents through its development of universal treatment standards (UTS) at 40 CFR §268.48 as well as its development of treatment standards for "U and P" listed wastes at 40 CFR

§268.40. EPA found that all but five of these constituents are already included in the list of Universal Treatment Standards (UTS) at 40 CFR 268.48. The remaining constituents of concern were dioxin and furan congeners, *1,2,3,4,6,7,8*-heptachlorodibenzo-*p*-dioxin, *1,2,3,4,6,7,8*-heptachlorodibenzofuran, *1,2,3,4,7,8,9*-heptachlorodibenzofuran, *1,2,3,4,6,7,8,9*-octachlorodibenzo-*p*-dioxin, and *1,2,3,4,6,7,8,9*-octachlorodibenzofuran. EPA calculated treatment standards based on the properties of these individual compounds and existing treatment data as available, and EPA is today proposing to add these constituents to the UTS table. The development of these standards are discussed in Appendix A.

A universal standard is a single concentration limit established for a specific constituent regardless of the waste matrix in which it is present (i.e., the same treatment standard applies to a particular constituent in each waste code in which it is regulated). Universal treatment standards represent a significant improvement in the LDR program. In the past, different listed hazardous wastes may have had different concentration standards for the same constituent, which raised significant compliance problems when wastes with different standards for the same chemical were comanaged. With the universal treatment standards, the variability in constituent concentrations across listed hazardous waste treatment standards was eliminated. Now, when a mixture of listed hazardous wastes is treated, the constituents must be treated to the same constituent concentration standard regardless of the waste codes contained in the mixture. Universal treatment standards were developed

EPA has established two different sets of universal treatment standards: one for nonwastewater forms of waste and one for wastewater forms of waste. These two sets differ in the population of regulated constituents and the individual universal treatment standards. A more detailed discussion concerning the determination of these treatment standards is provided in EPA's Proposed Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards, Volume A: Universal Standards for Nonwastewater Forms of Listed Hazardous Wastes and EPA's Proposed Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards, Volume B: Universal Standards for Wastewater Forms of Listed Hazardous Wastes.

1.3 Contents of This Document

Section 2.0 of this document describes the industry and processes generating Hazardous Waste Nos. K173, K174, and K175, the basis for listing chlorinated aliphatic wastes as hazardous, and waste stream characteristics. Section 3.0 presents the constituents selected for development of treatment standards for these wastes. Sections 4.0, 5.0, and 6.0 discuss the treatment technologies EPA has designated as "applicable" and "demonstrated" for K173, K174, and K175, respectively, identifies BDAT for wastewater and nonwastewater forms of these wastes, and presents the proposed treatment standards. References are listed in Section 7.0. The development of numerical treatment standards for certain dioxin and furan compounds is presented in Appendix A.

2.0 DESCRIPTION OF CHLORINATED ALIPHATICS WASTES PROPOSED FOR LISTING

2.1 Industry Overview

2.1.1 Introduction

EPA defines a chlorinated aliphatic as any organic compound characterized by a straight-chain, branched-chain, or cyclic hydrocarbons containing one to five carbons, with varying amounts and locations of chlorine substitution. Hydrocarbons are organic compounds composed solely of the atoms hydrogen and carbon. Aliphatics occur where chemical bonding between carbon atoms are single, double, or triple covalent bonds (not aromatic bonds). Cyclic aliphatic hydrocarbons included in this class consist of alkanes, alkenes or alkadienes, or alkynes. For an aliphatic to be chlorinated, the hydrogen atoms in the "aliphatic hydrocarbon" have been chemically replaced with chlorine atoms, at different positions and also in multiple positions.

2.1.2 Industry Study Profile

EPA's principal data sources in collecting information regarding the industry, their products and wastes, waste characteristics, and waste generation and management were as follows:

- A questionnaire developed under the authority of RCRA §3007 for distribution to the chlorinated aliphatics production industry. EPA distributed the survey in November of 1992 to collect data characterizing operations in 1991. In June of 1997 EPA sent requests for updated data (for calendar year 1996) regarding consent decree wastes generated by each facility.

- EPA conducted engineering site visits at 16 facilities to obtain more detailed information regarding waste generation and management. EPA also collected a total of 15 familiarization samples at these facilities to assess the effectiveness of the laboratory analytical methods for the analysis for analysis of the consent decree wastes, wastewaters and wastewater sludges. None of the familiarization sampling data are presented in this report, for use either in treatment standard development or selecting constituents for proposed regulation.

- EPA conducted record sampling activity at twelve facilities. Nine facilities were located in Louisiana and Texas, and three were located in Tennessee and Kentucky. These facilities were selected in order to obtain the most representative

sampling of all chlorinated aliphatics processes. EPA collected 52 samples (41 wastewaters and 11 wastewater treatment sludges). The use of record sampling data in this report is discussed in Section 2.3.2.

Ethylene dichloride and vinyl chloride monomer production overwhelmingly comprises the largest market, in terms of production volume and number of facilities involved, in the chlorinated aliphatics industry. EPA's investigation of the industry, as well as investigation of publically available data sources such as www.chemexpo.com, show that other products can include chlorinated methanes, chlorinated ethanes and ethylenes, and higher chlorinated compounds (up to five carbon lengths).

2.2 Processes Generating Hazardous Wastes

EPA is proposing to list as hazardous three wastes. The proposed regulatory definitions of these wastes are presented in Section 1. In summary, these wastes are as follows:

- K173 are wastewaters from the production of almost all chlorinated aliphatic hydrocarbons (i.e., except the VCM-A process which is discussed later in this section).
- K174 are wastewater treatment sludges from the production of ethylene dichloride or vinyl chloride monomer from the balanced process.
- K175 are wastewater treatment sludges from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process (i.e., the VCM-A process).

Two production processes are discussed in this section; the production of ethylene dichloride and vinyl chloride monomer (EDC/VCM) using the balanced process and production of VCM using the acetylene process (i.e., VCM-A process). These processes generate wastes K174 and K175, respectively. K173 can be generated from any chlorinated aliphatics production process, except the VCM-A process. Industry-wide, however, the majority of K173 is generated from the EDC/VCM balanced process.

An additional consideration regarding constituents potentially present in these wastes is that chlorinated aliphatics production facilities are primarily located in and around the petroleum

industry along the Gulf Coast. The majority of these facilities are fully integrated petrochemical processing facilities in which chlorinated aliphatic wastewaters are co-managed with non-chlorinated aliphatic wastewaters creating a non-dedicated wastewater treatment sludge. Additionally, if wastewaters not associated with chlorinated aliphatics production are mixed at the headworks with chlorinated aliphatics wastewaters (proposed as K173), then additional contaminants not typically associated with K173, or necessarily studied, would be present in the wastes.

2.2.1 Ethylene Dichloride/ Vinyl Chloride Production Using the Balanced Process

Fifteen facilities generate wastewater treatment sludge from the manufacture of EDC and/or VCM via the "balanced process." The balanced process consists of the following three primary reactions steps:

1) direct chlorination of ethylene to produce EDC:

$$CH_2=CH_2 + Cl_2 \rightarrow ClCH_2CH_2Cl$$

2) thermal cracking of EDC (following purification from previous step) to produce VCM and hydrogen chloride:

$$ClCH_2CH_2Cl \rightarrow CH_2=CHCl + HCl$$

3) oxychlorination of ethylene and HCl from thermal cracking to produce EDC:

$$CH_2=CH_2 + 2HCl + \tfrac{1}{2} O_2 \rightarrow ClCH_2CH_2Cl + H_2O$$

This process results in the production of water as a reaction product. This water is removed in product purification. The overall reaction from these three steps is the production of vinyl chloride as follows:

$$2\ CH_2=CH_2 + Cl_2 + \tfrac{1}{2} O_2 \rightarrow 2\ CH_2=CHCl + H_2O$$

As shown in the overall reaction, ethylene dichloride is consumed as an intermediate in the

reaction to vinyl chloride, and this is the typical case at many facilities. However, in some cases EDC is manufactured on-site and sent off-site as a product or purchased from an off-site source and used on-site to manufacture VCM.

Following the manufacture of VCM, many facilities consume VCM on-site as an intermediate in the manufacture of polyvinyl chloride (PVC), however, this polymerization reaction was not investigated in the course of the Industry Study.

Wastewaters produced during the EDC/VCM production process are mainly generated from distillation and purification processes, scrubbers used during start-up/shut-down, washings, phase separation, rainwater, and equipment washdowns. All would be classified as K173.

Wastewater treatment sludges are generated from the treatment of EDC/VCM wastewaters. These sludges would be classified as K174. Sludges are generally dewatered using either plate-and-frame filter presses or belt filter presses and dewatered sludge is temporarily stored in roll-off containers prior to on-site or off-site transportation and management.

2.2.2 VCM Production Using the Acetylene Process (VCM-A)

Production of VCM based on acetylene is less common than the aforementioned EDC/VCM balanced process using ethylene as feedstock. In fact, EPA identified only one facility that produces VCM using the VCM-A process. The VCM-A process produces only a small fraction of total vinyl chloride monomer in comparison to the balanced process. In this process, VCM is manufactured via the hydrochlorination of acetylene using a mercuric chloride catalyst. The basic process chemistry is as follows:

$$CH{\equiv}CH + HCl \rightarrow CH_2{=}CHCl$$

In this process, acetylene from the on-site acetylene plant is first purified to remove water. Following drying, the acetylene is mixed with anhydrous hydrogen chloride (HCl) and flows

through tubular catalytic reactors containing mercuric chloride supported on activated carbon. Once in the reactors, the acetylene and HCl combine to form VCM. The reactor products are sent to a phase separator. The liquid phases, consisting primarily of VCM, are forwarded to purification.

VCM purification consists of a series of distillation columns. Through this series of columns, the following compounds are recovered:

- Unreacted HCl and acetylene, which are recycled back to the reactors.
- Purified VCM, which is sold as a product.
- "Heavy ends" from the process. These are combusted onsite.

Water is not a reaction byproduct. The only wastewater generated from this process is rainwater and other padwater collected from the process area. Due to the presence of residual mercuric chloride catalyst from catalyst change-outs on the process pad, the padwater (containing mercury) is forwarded to a separate sodium sulfide treatment system prior to being discharged under an NPDES permit. This wastewater is not part of the proposed scope of K173, and is not proposed to be listed. Mercury sulfide wastewater treatment sludge is generated from the treatment of the process area padwater. This sludge is dewatered prior to temporary storage on-site in a container. This is proposed to be regulated as K175.

EPA collected a single sample from this facility's wastewater treatment sludge during its record sampling activities. Analysis determined that the sludge had very high levels of mercury (9,200 ppm of total mercury; 0.26 ppm of mercury by the TCLP). The TCLP concentration exceeds the maximum concentration for the Toxicity Characteristic (0.2 ppm -- D009). However, in 1988 the Louisiana DEQ determined the waste was not hazardous, and therefore not subject to many RCRA regulations (including land disposal restrictions for D009). Although the sludge has this nonhazardous designation, it is sent to a hazardous waste landfill in Carlyes Louisiana for disposal.

2.3 Waste Stream Characteristics

2.3.1 Sampling and Analysis Methodology

For the characterization of K173, K174, and K175 wastes, EPA primarily used information gathered from the record sampling activities discussed in Section 2.1. The target compounds were grouped into the following categories for analysis:

- Volatiles, SW-846 Method 8260A (44 analytes)
- Semi-volatiles, SW-846 Method 8270B (68 analytes)
- Metals, Methods Sw-846 Methods 6010, 7470/7471, 7770, 7841 (24 analytes)
- Dioxins and furans, Office of Water Method 1613[1] (25 analytes)

In addition, the Toxicity Characteristic Leaching Procedure (TCLP), Method 1311, was used in the analysis of all wastewater treatment sludge samples, with the same analytes as listed above. Additional characterization procedures were also performed on the wastewater and sludge samples: Total Organic Carbon (TOC), total dissolved solids (TDS), total suspended solids (TSS), and oil and grease were determined for some of the wastewater samples; and TOC, percent solids, oil and grease, and heat content (BTU) analyses were determined for some of the wastewater treatment sludge samples.

2.3.2 Waste Stream Characterization

General waste chemistry data are summarized in Table 2-1 for K173, K174, and K175. Data characterizing hazardous constituents in K173, K174, and K175 are presented in Section 3. Data regarding the general chemical and physical nature of the waste are useful in assessing the applicability of treatment techniques, anticipate any potential difficulties with treatment, and assessing if the wastes would likely be wastewaters or nonwastewaters when initially generated by the facilities.

[1] In its analyses, EPA used a method which was a compilation of Office of Water Method 1613 and SW-846 Method 8290.

Evaluation of Table 2-1 demonstrates that facilities that generate K173 may, in fact, be subject to treatment standards based on either wastewater or nonwastewater forms of the waste. Specifically, the TSS content of K173 is up to 1.8 percent and the TOC content is up to 0.16 percent. For LDR treatment standard implementation, wastewaters are wastes that contain less than 1 percent by weight TSS and less than 1 percent by weight TOC [40 CFR §268.2(f)]. Because K174 and K175 are sludges, they are nonwastewaters when generated.

Other significant information from examination of Table 2-1 is that K175 has a significantly greater oil and grease content than K174. The heat content of K175 (1,100 BTU/lb) is lower than 5,000 BTU/lb, which is one of the criteria for burning hazardous waste for metals recovery in an conditionally exempt manner (40 CFR §266.100(c)(2)(ii)).

Although EPA collected and analyzed 41 samples of wastewaters generated from the production of chlorinated aliphatic chemicals, only 6 of these samples were used in assessing treatment standard development or constituent selection for K173 (data for these same samples were used in the risk assessment). These six samples were collected at the influent (or "headworks") of wastewater treatment systems that manage only wastewaters derived from the production of chlorinated aliphatic chemicals. These wastewaters were considered "dedicated" to chlorinated aliphatics production.

Of the seven EDC/VCM sludge streams that were sampled during the Industry Study, four are considered "dedicated." Samples are considered dedicated when the only processes contributing to the waste streams are from the desired process (i.e., the four sludges are generated *only* from the treatment of wastewaters generated from the manufacture of EDC/VCM; no other processes contribute to the wastewater treatment sludge). The characterization data for these four sludge samples were used in performing the risk assessment for the listing determination. These same data are used to characterize the EDC/VCM sludge waste streams for treatment standard development and constituent selection for this report. EPA collected a single sample of K175 during its record sampling activities; data from this sample were used in treatment standard development.

Table 2-1. General Chemistry Data for K173, K174, and K175

Parameter	Result	Comments
K173		
TDS	0.6 to 1.8 percent	Results from 2 samples
TSS	<0.001 to 0.14 percent	Results from 6 samples
TOC	0.002 to 0.16 percent	Results from 6 samples
Oil and Grease	< 1 mg/L	Results from 4 samples
K174		
TOC	0.37 to 6.8 percent	Results from 2 samples
Oil and Grease	0.07 to 0.1 percent	Results from 2 samples
K175		
TOC	2.3 percent	Results from 1 sample
Oil and Grease	4.2 percent	Results from 1 sample
BTU/lb	1,100	Results from 1 sample
Percent Solids	44 percent	Results from 1 sample

3.0 SELECTION OF CONSTITUENTS FOR REGULATION

This section presents the methodology and rationale for selecting constituents for proposed regulation in nonwastewater and wastewater forms of K173, K174, and K175. Constituents were selected for proposed regulation because they are present in the wastes at high levels, relative to either of the following: (1) concentrations which would cause the waste to exhibit risks below EPA risk criteria (i.e., they are present as the proposed basis for listing), or (2) concentrations known to be achievable by available, well-operated technologies for reducing the toxicity of the waste (i.e., they are present in the wastes above UTS). While many other constituents may be present in the wastes, EPA generally elected not to develop treatment standards due to the following reasons:

- They are expected to be present in the wastes at levels below those anticipated to be achievable in a well-designed and applicable waste treatment unit. Development of proposed numerical treatment standards for such constituents would not result in reduced toxicity of the waste, because the waste would likely meet the proposed treatment standards even without waste treatment.

- They are expected to be treated concurrently with other constituents. It is common for a single treatment technology to reduce the toxicity or mobility of many constituents. Therefore, treatment standards proposed for a small number of constituents would necessarily result in the waste being effectively treated for other constituents not proposed for regulation. To assist in such determinations, EPA uses treatability groups to identify similarities in compounds.

This section identifies those constituents in K173, K174, and K175 wastes for which treatment standards are to be developed. Subsequent sections of this report describe applicable and demonstrated technologies for effectively treating wastes for such constituents, and develops appropriate numerical or technology-specific treatment standards for each of the wastes.

3.1 Constituents Proposed as the Bases for Listing

In its risk assessment, EPA found that certain constituents present in K173, K174, and K175 pose unacceptable risks to human health and the environment. The following constituents are proposed to be included as the basis for listing these wastes (i.e., proposed for inclusion in 40 CFR Appendix VII):

- K173 and K174 (the same constituents are used as the basis for listing for each waste:
  1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin (1,2,3,4,6,7,8-HpCDD),
  2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8,-HpCDF),
  1,2,3,4,7,8,9-Heptachlorodibenzofuran (1,2,3,6,7,8,9-HpCDF),
  HxCDDs (All Hexachlorodibenzo-*p*-dioxins),
  HxCDFs (All Hexachlorodibenzofurans),
  1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin (OCDD)
  1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)
  PeCDDs (All Pentachlorodibenzo-*p*-dioxins),
  PeCDFs (All Pentachlorodibenzofurans),
  TCDDs (All tetrachlorodibenzo-*p*-dioxins),
  TCDFs (All tetrachlorodibenzofurans).

- K175: Mercury.

Additionally, for K174, EPA found risks for arsenic that were within its discretionary range for using the constituent as a basis for listing. However, EPA is not proposing to include arsenic as a basis for listing this waste.

3.2 Other Constituents Present in Wastes

EPA identified additional constituents in the wastes that were present at levels higher than (or comparable to) universal treatment standards. As discussed in Section 1, universal treatment standards were developed from waste treatment data representing BDAT. Therefore, wastes with high concentrations (relative to UTS) of hazardous constituents should be capable of being treated to lower contaminant levels.

Tables 3-1, 3-2, and 3-3 were developed to assist in this comparison. Each of these tables characterize a different waste (i.e., K173, K174, and K175, respectively). These tables present the maximum concentrations of each contaminant constituents detected in K173, K174, and K175 wastes consistent with the discussion presented in Section 2.3.2 (i.e., based on record sampling results for a portion of the samples collected and analyzed). These concentrations were then compared to the compound's respective UTS value. If the maximum concentration of the compound in any sample exceeded the respective UTS, it was identified for additional

consideration (these compounds are marked in bold on the table). Any constituents not marked in bold were found at levels below their respective UTS values.

EPA evaluated constituents in K173 against wastewater UTSs because K173 is likely to be generated as a wastewater (as identified from data in Section 2.3.2); EPA could have also evaluated constituents in K173 against nonwastewater UTS, however these standards are much higher than wastewater standards. Therefore, this comparison was not as conservative and not necessary. K174 and K175 are evaluated against nonwastewater UTSs because they are sludges.

In some cases, organic constituents were not found during analysis of the total waste but was detected in TCLP leachate and this is also designated where appropriate. For organics in nonwastewaters, UTS are typically expressed as total concentrations (for metals, leachate concentrations are used). Detailed review of some of these organic constituents shows that the detection limits used were well below their UTS levels, indicating that constituents found only in TCLP leachate are not expected to be present above UTS during total analysis.

Additionally, each of the constituents identified in Tables 3-1 to 3-3 were organized into one of eleven treatability groups. These groupings are consistent with those used in developing UTS (EPA, 1994). This division is useful in assessing the difficulty of treating certain constituents such as those without UTS. The treatability groups relevant for compounds found in these wastes are as follows:

- Aromatic Hydrocarbons;
- Carbon Disulfide;
- Chlorobenzenes;
- Chloroethers;
- Halogenated Volatiles;
- Metals;
- Organo-Bromines;
- Oxygenated Hydrocarbons;
- PCBs and Dioxins/Furans;
- Phthalates; and
- Polynuclear Aromatic Hydrocarbons.

Comparison of the maximum waste concentrations to the UTS values in Tables 3-1 to 3-3 demonstrate the following:

- K173 waste concentrations of the following constituents exceed wastewater UTS standards (these are noted using boldface in Table 3-1): Chloroform, bis (2-chloroethyl) ether, phenol, 2,4,6-trichlorophenol, chromium, nickel, zinc, TCDFs, PeCDFs, HxCDDs, and HxCDFs. Additionally, waste concentrations of some individual dioxin/furan isomers exceed wastewater UTS for the class of dioxin or furan compounds. These individual compounds include the following: 1,2,3,6,7,8-HxCDD; 1,2,3,7,8,9-HxCDD; 1,2,3,4,7,8-HxCDF; 1,2,3,6,7,8-HxCDF; 1,2,3,7,8,9-HxCDF; 2,3,4,6,7,8-HxCDF; 2,3,4,7,8-PeCDF; and 2,3,7,8-TCDF.

- For K174, only one constituent shows waste concentrations in excess of its nonwastewater UTS standard (noted using boldface in Table 3-2). This compound is 1,2,3,4,7,8-HxCDF.

- For K175, the following constituents exceed their nonwastewater UTS standards (noted using boldface in Table 3-3): mercury and zinc.

3.3 Constituents Selected for Proposed Regulation

In identifying constituents selected for proposed regulation in 40 CFR 268.40 for K173, K174, and K175, EPA employed the following considerations:

- EPA is proposing treatment standards for each of the constituents proposed as the basis for listing of K173, K174, and K175. Establishing treatment standards for these particular constituents will best ensure that risks from these wastes are minimized, as required by RCRA Section 3004(m).

- EPA is proposing numerical treatment standards for additional constituents detected in the wastes at levels greater than UTS. The proposal of numerical standards will help ensure that adequate treatment will take place, and therefore reduce the overall toxicity of the wastes. For K173, the maximum waste concentrations were compared to wastewater UTS; this was the most appropriate comparison because K173 is aqueous and likely to be a wastewater (as defined by 40 CFR 268.2). For K174 and K175 the maximum waste concentrations were compared to nonwastewater UTS because these wastes, when generated, are nonwastewaters.

- Zinc, although present in K173 and K175 above its respective UTS, was not proposed as a constituent for inclusion in 40 CFR 268.40 for these wastes. This is because zinc does not meet the EPA definition of hazardous constituent or "underlying hazardous constituent." EPA defines an underlying hazardous constituent as "any constituent listed in 40 CFR 268.48, Table UTS-Universal

Treatment Standards, except fluoride, selenium, sulfides, vanadium, and zinc, which can reasonably be expected to be present at the point of generation of the hazardous waste at a concentration above the constituent-specific UTS treatment standards" [40 CFR 268.2(i)].

- The concentration of pentachlorophenol in K173 is slightly less than its corresponding UTS value. Its maximum waste concentration was 0.06 mg/L, and its wastewater UTS value is 0.089 mg/L. Proposing a numerical treatment standard allows for uncertainty and variability in the composition of K173 (i.e., some facilities may generate K173 at levels exceeding the UTS).

- For K174, arsenic is present at levels below its corresponding UTS value (0.053 mg/L versus a UTS of 5 mg/L). Health risks due to arsenic through the ground water pathway were identified in EPA's risk assessment, although the constituent is not proposed as a basis for listing. Nevertheless, due to the well-documented health risks from arsenic, including risks evaluated for K174, EPA is proposing a treatment standard for arsenic to ensure that risks from this constituent are minimized.

Several remaining constituents identified in the wastes were not further evaluated, in part because UTS do not exist for these compounds. Additionally, other chlorinated aliphatic compounds manufactured as products (and therefore potentially present in the wastes) were not evaluated. However, for many of these compounds the concentrations in the waste were comparable to levels found for other constituents of similar structure. Further, treatment techniques which reduce the concentration or mobility of other constituents proposed to be included in 40 CFR 268.40 for K173, K174, and K175 would also likely reduce the concentrations of these other products or constituents without UTS. For example, treatment techniques which destroy dioxins and furans are also likely to decrease concentrations of OCDD and OCDF (for which numerical treatment standards are not being proposed), and treatment techniques that destroy chloroform (a constituent proposed for inclusion on 40 CFR 268.40) would likely destroy other chlorinated aliphatics products.

In summary, EPA is proposing treatment standards for K173, K174, and K175 for the following constituents, for inclusion in 40 CFR 268.40. These constituents were principally selected by examining the constituents proposed as the basis for listing, examining concentrations of the constituents in the waste, and considering whether the contaminant is an "underlying hazardous constituent." The specific numerical or technology-specific standards to be proposed

for each constituent in each waste are presented in the following sections, following discussion of treatment technologies appropriate for minimizing the presence or mobility of the constituent in the wastes. The constituents selected for proposed treatment standards are as follows:

- **K173**
  Bis(2-chloroethyl)ether
  Chloroform
  Pentachlorophenol
  Phenol
  2,4,6-Trichlorophenol
  1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin (1,2,3,4,6,7,8-HpCDD)
  1,2,3,4,6,7,8- Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)
  1,2, 3,4,7,8,9-Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)
  HxCDDs (All Hexachlorodibenzo-*p*-dioxins)
  HxCDFs (All Hexachlorodibenzofurans)
  1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin (OCDD)
  1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)
  PeCDDs (All Pentachlorodibenzo-*p*-dioxins)
  PeCDFs (All Pentachlorodibenzofurans)
  TCDDs (All tetrachlorodibenzo-*p*-dioxins)
  TCDFs (All tetrachlorodibenzofurans)
  Chromium (Total)
  Nickel

- **K174**
  1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin (1,2,3,4,6,7,8-HpCDD)
  1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)
  1,2,3,4,7,8,9- Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)
  HxCDDs (All Hexachlorodibenzo-*p*-dioxins)
  HxCDFs (All Hexachlorodibenzofurans)
  1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin (OCDD)
  1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)
  PeCDDs (All Pentachlorodibenzo-*p*-dioxins)
  PeCDFs (All Pentachlorodibenzofurans)
  TCDDs (All tetrachlorodibenzo-*p*-dioxins)
  TCDFs (All tetrachlorodibenzofurans)
  Arsenic

- **K175**
  Mercury

Table 3-1. Constituents Detected in K173

Constituent	Treatability Group	UTS WW (mg/L)	UTS NWW (mg/kg)	Maximum Concentration (mg/L unless otherwise noted)
Constituents with UTS				
1,2-Dichloroethane	Halogenated Volatile	0.21	6.0	0.082
2-Chloro-1,3-butadiene	Halogenated Volatile	0.057	0.28	0.016
Acetone	Oxygenated Hydrocarbon	0.28	160	0.120
Allyl chloride (3-Chloropropylene)	Halogenated Volatile	0.036	30	0.017
Bromodichloromethane	Organo-Bromine	0.35	15	0.0025
Bromoform	Organo-Bromine	0.63	15	0.0025
Carbon disulfide	Carbon Disulfide	3.8	4.8 mg/L TCLP	0.012
Chlorobenzene	Chlorobenzenes	0.057	6.0	0.010
Chloroethane	Halogenated Volatile	0.27	6.0	0.016
Chloroform	**Halogenated Volatile**	**0.046**	6.0	**0.700**
Dibromochloromethane	Organo-Bromine	0.057	15	0.0025
Ethylbenzene	Aromatic Hydrocarbon	0.057	10	0.0029 J
Methyl ethyl ketone	Oxygenated Hydrocarbon	0.28	36	0.035
Methylene chloride	Halogenated Volatile	0.089	30	0.0053 J
Tetrachloroethylene	Halogenated Volatile	0.056	6.0	0.0088
Trans-1,2-Dichloroethene	Halogenated Volatile	0.054	30	0.003 J

Constituent	Treatability Group	UTS WW (mg/L)	UTS NWW (mg/kg)	Maximum Concentration (mg/L unless otherwise noted)
Trichloroethylene	Halogenated Volatile	0.054	6.0	0.011
4-Aminobiphenyl	Halogenated Volatile	0.13	NA	0.02 J
Bis(2-chloroethyl)ether	**Chloroether**	**0.033**	6.0	**0.26**
Bis(2-chloroisopropyl)ether	Chloroether	0.055	7.2	0.024
Hexachlorobenzene	Chlorobenzene	0.055	10	0.005
2-Methylphenol (o-Cresol)	Phenols	0.11	5.6	0.014
4-Methylphenol (m-Cresol)	Phenols	0.77	5.6	0.024
Pentachlorophenol	Chlorinated Phenols	0.089	7.4	0.06
Phenol	**Chlorinated Phenols**	**0.039**	6.2	**0.16**
2,4,5-Trichlorophenol	Chlorinated Phenols	0.18	7.4	0.02
2,4,6-Trichlorophenol	**Chlorinated Phenols**	**0.035**	7.4	**0.093**
Diethyl phthalate	Phthalate	0.20	28	0.09
Dimethyl phthalate	Phthalate	0.047	28	0.0087 J
Di-n-octyl phthalate	Phthalate	0.017	28	0.0057 J
Bis (2-ethyl hexyl) phthalate	Phthalate	0.28	28	0.0074
Arsenic	Metal	1.4	5.0 mg/L TCLP	0.07
Barium	Metal	1.2	7.6 mg/L TCLP	0.31
Beryllium	Metal	0.82	0.014mg/L TCLP	0.01
Chromium	**Metal**	**2.77**	0.86 mg/L TCLP	**2.86**
Lead	Metal	0.69	0.37 mg/L TCLP	0.12

Constituent	Treatability Group	UTS WW (mg/L)	UTS NWW (mg/kg)	Maximum Concentration (mg/L unless otherwise noted)
Mercury	Metal	0.15	0.025mg/L TCLP	0.0008
Nickel	**Metal**	**3.98**	5.0mg/L TCLP	**40.6**
Vanadium	Metal	4.3	0.23 mg/L TCLP	0.03
Zinc	**Metal**	**2.61**	5.3 mg/L TCLP	**3.9**
1,2,3,4,7,8-HxCDD	Dioxins/Furans	0.000063	0.001	0.000052
1,2,3,6,7,8-HxCDD	**Dioxins/Furans**	**0.000063**	0.001	**0.000091**
1,2,3,7,8,9-HxCDD	**Dioxins/Furans**	**0.000063**	0.001	**0.00011**
1,2,3,4,7,8-HxCDF	**Dioxins/Furans**	**0.000063**	0.001	**0.0053**
1,2,3,6,7,8-HxCDF	**Dioxins/Furans**	**0.000063**	0.001	**0.0012**
1,2,3,7,8,9-HxCDF	**Dioxins/Furans**	**0.000063**	0.001	**0.0012**
2,3,4,6,7,8-HxCDF	**Dioxins/Furans**	**0.000063**	0.001	**0.00043**
2,3,4,7,8-PeCDF	**Dioxins/Furans**	**0.000035**	0.001	**0.00023**
2,3,7,8-TCDD	Dioxins/Furans	0.000063	0.001	0.000017
2,3,7,8-TCDF	**Dioxins/Furans**	**0.000063**	0.001	**0.000082**
Total HxCDD	**Dioxins/Furans**	**0.000063**	0.001	**0.00051**
Total HxCDF	**Dioxins/Furans**	**0.000063**	0.001	**0.0093**
Total PeCDF	**Dioxins/Furans**	**0.000035**	0.001	**0.0027**
Total TCDD	Dioxins/Furans	0.000063	0.001	0.000049
Total TCDF	**Dioxins/Furans**	**0.000063**	0.001	**0.00086**
Constituents without UTS				
cis-1,2-Dichloroethylene	Halogenated Volatile	--	--	0.0071
Styrene	Polynuclear Aromatic Hydrocarbon	--	--	0.0073
Benzoic Acid	Oxygenated Hydrocarbon	--	--	0.14

Constituent	Treatability Group	UTS WW (mg/L)	UTS NWW (mg/kg)	Maximum Concentration (mg/L unless otherwise noted)
Benzyl Alcohol	Oxygenated Hydrocarbon	--	--	0.013
Aluminum	Metal	--	--	44.6
Calcium	Metal	--	--	82.7
Cobalt	Metal	--	--	0.06
Copper	Metal	--	--	33.5
Iron	Metal	--	--	658
Magnesium	Metal	--	--	22.9
Manganese	Metal	--	--	3.69
Molybdenum	Metal	--	--	0.24
Potassium	Metal	--	--	53
Sodium	Metal	--	--	26400
1,2,3,4,6,7,8-HpCDD	Dioxins/Furans	--	--	0.00088
1,2,3,4,6,7,8-HpCDF	Dioxins/Furans	--	--	0.043
1,2,3,4,7,8,9-HpCDF	Dioxins/Furans	--	--	0.012
Total HpCDD	Dioxins/Furans	0.000035	0.0025	0.0013
Total HpCDF	Dioxins/Furans	0.000035	0.0025	0.06
OCDD	Dioxins/Furans	--	--	0.0069
OCDF	Dioxins/Furans	--	--	6

J - Compound's concentration is estimated.
Bolded constituents exceed their respective UTS for wastewater forms of waste.
UTS for dioxins and furans refer to the class (e.g., all TCDDs) rather than to specific constituents.

Table 3-2. Constituents Detected in K174

Constituent	Treatability Group	UTS WW (mg/L)	UTS NWW (mg/kg)	Maximum Concentration (mg/kg unless otherwise noted)
Constituents with UTS				
Acetone	Oxygenated Hydrocarbon	0.28	160	2
Allyl chloride (3-Chloropropylene)	Halogenated Volatile	0.036	30	0.008
2-Butanone (Methyl ethyl ketone)	Oxygenated Hydrocarbon	0.28	36	0.12
Carbon disulfide	Carbon Disulfide	3.8	4.8 mg/L TCLP	0.0072 mg/L TCLP
Chloroform	Halogenated Volatile	0.046	6.0	0.56
1,2-Dichloroethane	Halogenated Volatile	0.21	6.0	0.53
Methylene chloride	Halogenated Volatile	0.089	30	0.043
Tetrachloroethylene	Halogenated Volatile	0.056	6.0	0.018 J
Trichloroethylene	Halogenated Volatile	0.054	6.0	0.0028 J
Vinyl chloride	Halogenated Volatile	0.27	6.0	0.015 J
Bis(2-chloroethyl)ether	Chloroether	0.033	6.0	0.800
Bis(2-ethylhexyl) phthalate	Phthalate	0.28	28	5.9 J
Hexachlorobenzene	Chlorobenzene	0.055	10	0.11 J
Arsenic	Metal	1.4	5.0 mg/L TCLP	0.053 mg/L TCLP
Nickel	Metal	3.98	5.0 mg/L TCLP	1.3 mg/L TCLP
Zinc	Metal	2.61	5.3 mg/L TCLP	4.0 mg/L TCLP
1,2,3,4,7,8-HxCDD	Dioxins/Furans	0.000063	0.001	0.02 µg/kg
1,2,3,6,7,8-HxCDD	Dioxins/Furans	0.000063	0.001	0.083 µg/kg

Constituent	Treatability Group	UTS WW (mg/L)	UTS NWW (mg/kg)	Maximum Concentration (mg/kg unless otherwise noted)
1,2,3,7,8,9-HxCDD	Dioxins/Furans	0.000063	0.001	0.062 µg/kg
1,2,3,4,7,8-HxCDF	**Dioxins/Furans**	0.000063	**0.001**	**1.425 µg/kg**
1,2,3,6,7,8-HxCDF	Dioxins/Furans	0.000063	0.001	0.3 µg/kg
1,2,3,7,8,9-HxCDF	Dioxins/Furans	0.000063	0.001	0.14 µg/kg
2,3,4,6,7,8-HxCDF	Dioxins/Furans	0.000063	0.001	0.648 µg/kg
1,2,3,7,8-PeCDF	Dioxins/Furans	0.000035	0.001	0.028 µg/kg
2,3,4,7,8-PeCDF	Dioxins/Furans	0.000035	0.001	0.127 µg/kg
1,2,3,7,8-PeCDD	Dioxins/Furans	0.000063	0.001	0.04 µg/kg
2,3,7,8-TCDD	Dioxins/Furans	0.000063	0.001	0.039 µg/kg
2,3,7,8-TCDF	Dioxins/Furans	0.000063	0.001	0.145 µg/kg
Constituents without UTS				
2-Hexanone	Oxygenated Hydrocarbon	--	--	0.0025
Vinyl acetate	Oxygenated Hydrocarbon	--	--	0.007
Benzoic acid	Oxygenated Hydrocarbon	--	–	0.19 J
Calcium	Metal	--	--	848 mg/L TCLP
Cobalt	Metal	--	--	0.07 mg/L TCLP
Copper	Metal	--	--	22.3 mg/L TCLP
Magnesium	Metal	--	--	154 mg/L TCLP
Manganese	Metal	--	--	12.9 mg/L TCLP
Molybdenum	Metal	--	--	0.022 mg/L TCLP
Potassium	Metal	--	--	9.3 mg/L TCLP
1,2,3,4,6,7,8-HpCDD	Dioxins/Furans	--	--	0.777 µg/kg
1,2,3,4,6,7,8-HpCDF	Dioxins/Furans	--	--	20.7 µg/kg
1,2,3,4,7,8,9-HpCDF	Dioxins/Furans	--	--	13.5 µg/kg
OCDD	Dioxins/Furans	--	--	6.48 µg/kg
OCDF	Dioxins/Furans	--	--	212 µg/kg

J - Compound's concentration is estimated.

Bolded constituents exceed their respective UTS for nonwastewater forms of waste.

UTS for dioxins and furans refer to the class (e.g., all TCDDs) rather than to specific constituents.

Table 3-3. Constituents Detected in K175

Constituent	Treatability Group	UTS WW (mg/L)	UTS NWW (mg/kg)	Maximum Concentration (mg/kg unless otherwise noted)
Constituents with UTS				
Carbon disulfide	Carbon Disulfide	3.8	4.8 mg/L TCLP	0.014 mg/L TCLP
1,2-Dichlorobenzene	Chlorobenzene	0.088	6.0	2.01
1,3-Dichlorobenzene	Chlorobenzene	0.036	6.0	0.7
1,4-Dichlorobenzene	Chlorobenzene	0.09	6.0	0.96
Bis(2-ethylhexyl)benzene	Aromatic Hydrocarbon	0.28	28	3.4
Fluoranthene	Polynuclear Aromatic Hydrocarbon	0.068	3.4	0.67
Pyrene	Polynuclear Aromatic Hydrocarbon	0.067	8.2	2.32
1,2,4-Trichlorobenzene	Aromatic Hydrocarbon	0.055	19	2.34
Di-n-butyl phthalate	Phthalate	0.057	28	20
Chromium	Metal	2.77	0.86 mg/L TCLP	0.10 mg/L TCLP
Mercury	**Metal**	0.15	**0.025 mg/L TCLP**	**0.26mg/L TCLP**
Nickel	Metal	3.98	5.0mg/L TCLP	1.0 mg/L TCLP
Zinc	**Metal**	2.61	**5.3 mg/L TCLP**	**9.5 mg/L TCLP**
1,2,3,4,7,8-HxCDF	Dioxins/Furans	0.000063	0.001	0.083 µg/kg
1,2,3,6,7,8-HxCDF	Dioxins/Furans	0.000063	0.001	0.0481 µg/kg
1,2,3,7,8,9-HxCDF	Dioxins/Furans	0.000063	0.001	0.0192 µg/kg
2,3,4,6,7,8-HxCDF	Dioxins/Furans	0.000063	0.001	0.0319 µg/kg
1,2,3,7,8-PeCDF	Dioxins/Furans	0.000063	0.001	0.0288 µg/kg
2,3,4,7,8-PeCDF	Dioxins/Furans	0.000035	0.001	0.0197 µg/kg
2,3,7,8-TCDF	Dioxins/Furans	0.000063	0.001	0.0101 µg/kg

Constituent	Treatability Group	UTS WW (mg/L)	UTS NWW (mg/kg)	Maximum Concentration (mg/kg unless otherwise noted)
Total HxCDD	Dioxins/Furans	0.000063	0.001	0.0656 µg/kg
Total HxCDF	Dioxins/Furans	0.000063	0.001	0.3758 µg/kg
Total PeCDF	Dioxins/Furans	0.000063	0.001	0.1704 µg/kg
Total TCDD	Dioxins/Furans	0.000063	0.001	0.0038 µg/kg
Total TCDF	Dioxins/Furans	0.000063	0.001	0.0481 µg/kg
Constituents without UTS				
Calcium	Metal	--	--	417 mg/L TCLP
Copper	Metal	--	--	0.64 mg/L TCLP
Magnesium	Metal	--	--	2.7 mg/L TCLP
Manganese	Metal	--	--	0.3 mg/L TCLP
Potassium	Metal	--	--	1.6 mg/L TCLP
1,2,3,4,6,7,8-HpCDD	Dioxins/Furans	--	--	0.1748 µg/kg
1,2,3,4,6,7,8-HpCDF	Dioxins/Furans	--	--	0.1093 µg/kg
1,2,3,4,7,8,9-HpCDF	Dioxins/Furans	--	--	0.0297 µg/kg
Total HpCDD	Dioxins/Furans	--	--	0.3496 µg/kg
Total HpCDF	Dioxins/Furans	--	--	0.1398 µg/kg
OCDD	Dioxins/Furans	--	--	1.44 µg/kg
OCDF	Dioxins/Furans	--	--	0.1005 µg/kg

Bolded constituents exceed their respective UTS for nonwastewater forms of waste.
UTS for dioxins and furans refer to the class (e.g., all TCDDs) rather than to specific constituents.
Organic constituents that are detected only in TCLP leachate are not presented here, because their NWW UTS is based on total analyses.

4.0 TREATMENT STANDARD DEVELOPMENT FOR K173

EPA is required to set as treatment standards "... levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized." [RCRA Section 3004(m)(1)]. The constituents proposed for treatment standard development were identified in Section 3.

To meet the requirements of the statute, EPA can propose either technology-specific or numerical treatment standards. In fact, EPA has previously promulgated numerical universal treatment standards for many of the constituents proposed for LDR regulation in K173. This section develops the proposed treatment standards for these constituents in wastewater and nonwastewater forms of K173 to best meet the requirements of RCRA Section 3004(m). The section is organized in the following manner:

- Section 4.1 summarizes the results of Section 3 and provides an overview of the treatment needs of the waste
- Section 4.2 discusses wastewater forms of K173. Specifically, technologies applicable for treating the constituents identified in the waste are discussed in Sections 4.2.1 to 4.2.3. The technology or technologies identified as BDAT are then presented in Section 4.2.4. Finally, the proposed treatment standards are developed in Section 4.2.5.
- Section 4.3 discusses nonwastewater forms of K173. The format of the discussion is similar to that for wastewater forms of K173.

4.1 Summary of Constituents Selected for Regulation

As presented in Section 3, the following constituents were identified for proposed treatment standard development:

- Bis(2-chloroethyl)ether
- Chloroform
- Pentachlorophenol
- Phenol
- 2,4,6-Trichlorophenol

- 1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin (1,2,3,4,6,7,8-HpCDD)
- 1,2,3,4,6,7,8- Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)
- 1,2, 3,4,7,8,9-Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)
- HxCDDs (All Hexachlorodibenzo-*p*-dioxins)
- HxCDFs (All Hexachlorodibenzofurans)
- PeCDDs (All Pentachlorodibenzo-*p*-dioxins)
- PeCDFs (All Pentachlorodibenzofurans)
- *1,2,3,4,6,7,8,9*-Octachlorodibenzo-p-dioxin (OCDD)
- *1,2,3,4,6,7,8,9*-Octachlorodibenzofuran (OCDF)
- TCDDs (All tetrachlorodibenzo-*p*-dioxins)
- TCDFs (All tetrachlorodibenzofurans)
- Chromium (Total)
- Nickel

These constituents represent three treatability groups: organics (including phenols, chlorinated phenols, chloroethers, and halogenated volatiles), dioxin/furans, and metals. Different treatment technologies are applicable for each category as described in the following sections. Sections 4.2.1, 4.2.2, and 4.2.3 discuss applicable treatment technologies for organics, dioxins/furans, and metals (respectively) in wastewater forms of wastes. Similar organization is presented in Section 4.3, for these constituents in nonwastewater forms of wastes.

4.2 Wastewater Forms of K173

As discussed in Section 2, K173 is an aqueous waste when generated, but depending on its percent solids content it may be classified as either a wastewater or a nonwastewater (40 CFR 268.2). The technologies listed here are expected to be applicable to wastewater forms of K173. Some of the technologies listed here are also expected to be applicable to nonwastewater forms of K173, as long as it has characteristics of a pumpable aqueous waste.

4.2.1 Applicable and Demonstrated Technologies for Treating Organics

To be applicable, a technology must theoretically be usable to treat the waste in question or a waste that is similar, in terms of parameters that affect treatment selection (EPA, 1994b). Applicable treatment technologies are those that destroy or reduce the total amount of organic constituents in the waste. The technologies listed below are applicable and have been

demonstrated to treat organic constituents in wastewater forms of other hazardous wastes. EPA (1994b) presents a thorough discussion of these technologies. The technologies applicable to the physical and chemical characteristics of K173 include the following:

- Biological treatment (including aerobic fixed film, aerobic lagoon, activated sludge, anaerobic fixed film, rotating biological contractor, sequential batch reactor, and trickling filter technologies)
- Carbon adsorption treatment (including activated carbon and granular activated carbon technologies)
- Chemically assisted clarification treatment (including chemical precipitation technology)
- Chemical oxidation
- PACT® treatment (including powdered activated carbon addition to activated sludge and biological granular activated carbon technologies)
- Reverse osmosis treatment
- Solvent extraction treatment (including liquid/liquid extraction)
- Stripping treatment (including steam stripping and air stripping technologies)
- Wet air oxidation treatment (including supercritical oxidation technology)
- Glycolate dechlorination
- Total recycle or reuse.

The concentrations and type(s) of constituents present in the waste generally determine which technology is most applicable. Carbon adsorption, for example, is often used as a polishing step following primary treatment by biological treatment, solvent extraction, or wet air oxidation. Typically, carbon adsorption is applicable for treatment of wastewaters containing less than 0.1% total organic constituents. Wet air oxidation, PACT® treatment, biological treatment, and solvent extraction are generally applicable for treatment of wastewaters containing up to 1% total organic constituents. Some wastewater forms of K173 may not be treated effectively by biological treatment or PACT® if they contain constituents that are too toxic to support biomass

growth.

Biological Treatment

Biological treatment is a destruction technology that biodegrades hazardous organic constituents in wastewaters. This technology generates two treatment residuals: a treated effluent and a waste biosludge.

Carbon Adsorption

Carbon adsorption is a separation technology that selectively adsorbs organic constituents in wastewaters onto activated carbon. This technology generates two treatment residuals: a treated effluent and spent activated carbon. The spent activated carbon may be reactivated, recycled, incinerated, or land disposed (in accordance with land disposal restrictions).

Chemically Assisted Clarification Treatment

Chemically assisted clarification, including chemical precipitation, is a separation technology that removes organic and inorganic constituents from wastewater by the addition of chemicals that cause the formation of precipitates. The solids formed are then separated from the waste water by settling, clarification, and/or polishing filtration. This technology generates two treatment residuals: treated wastewater effluent and separated solid precipitate.

Chemical Oxidation

Chemical oxidation is a destruction technology that oxidizes inorganic cyanide, some dissolved organic compounds, and sulfides to yield carbon dioxide, water, salts, simple organic acids, and sulfates. This technology generates one treatment residual; treated effluent.

PACT® Treatment

PACT® treatment combines carbon adsorption and biological treatment to biodegrade hazardous organic constituents and selectively adsorb them onto powdered activated carbon. This technology generates two treatment residuals: a treated effluent and spent carbon/biosludge. The spent carbon is often regenerated and recycled to the process or incinerated.

Reverse Osmosis

Reverse osmosis is a separation technology that removes dissolved organics (usually salts) from a wastewater by filtering the waste water through a semipermeable membrane at a pressure greater than the osmotic pressure caused by the dissolved organics in the wastewater. This technology generates two treatment residuals: the treated effluent and the concentrated organic salt materials which do not pass through the membrane.

Solvent Extraction

Solvent extraction is a separation technology that removes organic compounds from a waste due to greater constituent solubility in a solvent phase than in the waste phase. This technology generates two residuals: a treated waste residual and an extract.

Stripping Treatment

Stripping treatment is a separation technology in which volatile organic constituents in a liquid waste are physically transferred to a flowing gas or vapor. In steam stripping, steam contacts the waste, strips the volatile organics, and carries them to a condenser where the mixture of organic vapors and steam is condensed and collected in an accumulator tank. In air stripping, air contacts the waste and strips the volatile organic constituents. Stripping generates one treatment residual: treated effluent.

Wet Air Oxidation

Wet air oxidation is a destruction technology that oxidizes hazardous organic constituents in wastes under pressure at elevated temperatures in the presence of dissolved oxygen. This technology is applicable for wastes comprised primarily of water and with up to 10 percent total organic constituents. Wet air oxidation generates one treatment residual: treated effluent. The treated effluent may require further treatment for hazardous organic constituents by carbon adsorption or PACT® treatment. Trapped air emissions from wet air oxidation may also require further treatment.

Glycolate Dechlorination

The *Background Document for the Development of UTS for Wastewaters* (EPA, 1994c), describes a bench-scale process involving dechlorination of toxics (e.g., dioxins) using an alkoxide formed by the reaction of potassium hydroxide with polyethylene glycol (KPEG). The U.S. Navy's Environmental Restoration Division also provides another description of this process[2]. The KPEG technology is an example of the use of an alkaline polyethylene glycol reagent (APEG), and is considered as an innovative remediation technology applicable to small volume of soils (i.e., nonwastewaters) due to cost constraints. The process involves the mixing and heating of contaminated soils and the reagent in a batch treatment vessel. The reaction between the chlorinated organics and the KPEG causes replacement of a chlorine molecule with polyethylene glycol. The reagent then dehalogenates the pollutant to form a glycol ether and/or a hydroxylated compound and an alkali metal salt, which are water-soluble byproducts.

Total Recycle or Reuse

Total recycle or reuse within the same process or an external process eliminates waste generation and subsequently generates no residuals requiring additional treatment.

[2] http://www.nfesc.navy.mil/enviro/esc414/techinfo/shortlist/shortlist.htm. The date of the report was not provided, but appears to be from 1998.

4.2.2 Applicable and Demonstrated Technologies for Treating Dioxins/Furans

In general, technologies applicable to the treatment of organic compounds are applicable to dioxin/furan compounds. Section 4.2.1 provides a description of these applicable technologies.

4.2.3 Applicable and Demonstrated Technologies for Treating Metals

Applicable technologies for treating metals are those that remove, or transfer, metals from the wastewater to a nonwastewater media, such as a sludge. Several of the technologies described in Section 4.2.1 for organics are applicable for the metals because the metal species flocculate with the organic compounds and are removed in a sludge stream. The concentration of metals (e.g., arsenic) is expected to be low such that the metals could be treated in conjunction with organics, without contributing to the toxicity or causing other interferences. The technologies listed in this section are applicable and have been demonstrated to treat metal constituents in wastewater forms of other hazardous wastes. EPA (1994b) presents a thorough discussion of these technologies. The technologies applicable to the physical and chemical characteristics of K173 include:

- Biological treatment (including activated sludge, aerobic lagoon, rotating biological contractor, and trickling filter technologies);
- Chemically assisted clarification treatment (including chemical precipitation technology)
- Chemical oxidation
- PACT® treatment
- Chemical reduction treatment (including chemical reduction or precipitation followed by sedimentation and filtration technologies)
- Electrochemical treatment
- Lime, sedimentation, and filtration treatment.

The first four technologies are described in Section 4.2.1 for treating organics in K173

wastes. The remaining three technologies are described below.

Chemical Reduction Treatment

Chemical reduction treatment reduces metal constituents from a higher oxidation state to a lower oxidation state, and subsequently removes the contaminants from the wastewater using chemical precipitation and subsequent sedimentation and/or filtration. This technology generates two treatment residuals: a treated effluent and a settled or filtered solid containing the precipitated metal.

Electrochemical Treatment

Electrochemical treatment is a technology in which direct current is applied to iron electrodes submerged in the wastewater, generating ferrous ions. Metal constituents are removed by adsorbing and coprecipitating within insoluble ferrous ion matrices. These matrices settle out of solution using chemically assisted clarification (described in Section 4.2.1). This technology produces two treatment residuals: a treated effluent and a settled solid containing the precipitated metal.

Lime, Sedimentation and Filtration Treatment

As a separation technology, this treatment mixes wastewaters with lime (primarily calcium oxide) which produced an insoluble metal oxide which settles out of solution. The wastewater is filtered to remove the precipitated material. This treatment technology produces two residuals: a treated effluent and a filter cake containing lime and metals oxides.

4.2.4 Identification of BDAT for Wastewater Forms of K173

EPA determines BDAT for individual constituents, and wastes, upon review of all available performance data on treatment of the waste of concern or of similar wastes (EPA,

1994a). Once the applicable and demonstrated treatment technologies are identified for the particular waste, performance data are examined to identify the "best" performing technologies. This criteria includes:

- Whether the data represent the operation of a well-designed and well-operated treatment system;
- Whether sufficient analytical quality assurance/quality control measures were used to ensure the accuracy of the data; and
- Whether the appropriate measure of performance was used to assess the performance of the particular treatment technology.

Once this is determined, EPA decides where the best demonstrated technology is "available." EPA defines an available technology as one that:

- Is not a proprietary or patented process and can be purchased or licensed from the proprietor, and
- Substantially diminishes the waste's toxicity or substantially reduces the likelihood that hazardous contaminants will migrate from the waste (EPA, 1994a).

EPA determined the BDAT for the constituents requiring treatment in wastewater forms of K173. These constituents include five organics (bis(2-chloroethyl)ether, chloroform, pentachlorophenol, phenol, and 2,4,6-trichlorophenol), dioxins/furans, and two metals (chromium and nickel). In its development of UTS, EPA has identified BDAT for all but five constituents (i.e., hepta-and octa- dioxins and furans) proposed for treatment standard development in K173.

BDAT for Organics

Examination of the background document for development of UTS in wastewater forms of wastes for the five organic constituents identified above show that the following technologies were identified as BDAT (i.e., used for UTS development):

- Bis(2-chloroethyl ether): activated sludge biological treatment
- Chloroform: Steam stripping
- Pentachlorophenol: Filtration followed by granular activated carbon

- Phenol: Biological treatment
- 2,4,6-Trichlorophenol: Biological treatment

BDAT for Dioxins/Furans

In developing universal treatment standards for dioxin/furan constituents, EPA identified biological treatment as BDAT (EPA, 1994b). EPA developed UTS for the following dioxin/furan classes:

- HxCDDs (All Hexachlorodibenzo-*p*-dioxins)
- HxCDFs (All Hexachlorodibenzofurans)
- PeCDDs (All Pentachlorodibenzo-*p*-dioxins)
- PeCDFs (All Pentachlorodibenzofurans)
- TCDDs (All tetrachlorodibenzo-*p*-dioxins)
- TCDFs (All tetrachlorodibenzofurans)

EPA did not previously develop UTS for the remaining dioxin/furan congeners identified as the basis for listing K173. (These five constituents are 1,2,3,4,6,7,8-HpCDD; 1,2,3,4,6,7,8-HpCDF; 1,2,3,4,7,8,9-HpCDF; OCDD; and OCDF) Biological treatment is expected to perform equally well for these constituents as it does for the other congeners. This is because of the similarity in structure and properties of these compounds. Therefore, biological treatment is identified as BDAT for treating dioxin/furan compounds in K173 wastewaters.

BDAT for Metals

In developing UTS for chromium and nickel, EPA identified the appropriate BDAT as chemical precipitation followed by sedimentation (EPA, 1994b). In determining this BDAT, EPA used data collected from the Office of Water's Engineering and Analysis Division-Metal Finishing (EAD-MF) database. This database is considered representative of industry-wide treatment performance data and wastewaters generated via metals production.

BDAT for Wastewater Forms of K173: Conclusion

Biological treatment is a demonstrated method for treating wastewaters with low levels of

dioxin/furan components. In data submitted by industry prior to promulgation of the Land Disposal Restrictions for Third Third Scheduled Wastes (55 *FR* 22520), wastewaters including hazardous waste landfill leachate were managed using biological treatment in both batch and full scale processes.[3] In general, biological treatment is a common full scale treatment method in the organic chemicals manufacturing and is particularly common to the chlorinated aliphatics manufacturing industry. Data from biological treatment was also used in treatment standard development for several of the other organics proposed for LDR regulation in wastewater forms of K173.

However, for two organic compounds biological treatment was not identified as BDAT. Additionally, for the two metals biological treatment is expected to only slightly decrease their concentrations in the waste. Therefore, to adequately treat wastewater forms of K173 primary treatment steps may be necessary prior to biological treatment, consisting of steam stripping, activated carbon, and/or filtration.

4.2.5 Identification of Proposed Treatment Standards for Wastewater Forms of K173

EPA is proposing numerical treatment standards for all constituents identified for proposed treatment standard development. EPA is transferring universal treatment standards to the constituents selected for proposed regulation of wastewater forms of K173. Universal treatment standards have previously been promulgated for all but five of these constituents (i.e., hepta- and octa- dioxins and furans). For the three hepta-isomers constituents, the UTS promulgated for pentachlorodibenzofurans is proposed as the treatment standard for these three constituents. These three congeners are similar in chemical structure to pentachlorodibenzofurans and treatment to a similar level is therefore expected. Similarly, the UTS promulgated for tetrachlorodibenzo-*p*-dioxins and furans is proposed for OCDD and OCDF. More detailed discussion regarding the transfer of the existing UTS for pentachlorodibenzofurans to these five compounds is presented in Appendix A.

[3] Letter from Chemical Waste Management Incorporated, F-89-LD12-S0967. Letter from Dow Chemical USA, F-89-LD12-S0968.

Section 4.2.4 discusses the treatment train identified as BDAT for treating these constituents in wastewater forms of K173. EPA expects such a treatment train to result in treated effluent with contaminant concentrations lower than the numerical treatment standards. If the proposed numerical treatment levels are finalized for wastewater forms of K173, the use of any technology (other than impermissible dilution) would be allowed in complying with the treatment standards. Therefore, facilities are not required to use the above treatment train to manage wastewater forms of K173, and may find they can use an alternative treatment train to meet the proposed numerical treatment standards.

4.3 Nonwastewater Forms of K173

Many of the technologies discussed in Section 4.3 are expected to be applicable to nonwastewater forms of K173, as long as the waste resembles a pumpable aqueous waste. This section discusses technologies applicable to forms of K173 with a wide range of solids content.

4.3.1 Applicable and Demonstrated Technologies for Treating Organics

Applicable treatment technologies include those that destroy or reduce the total amount of organic constituents in the waste. The technologies listed in this section are applicable and have been demonstrated to treat organic constituents in nonwastewater forms of similar hazardous wastes. EPA (1994a) presents a thorough discussion of these technologies. Those technologies deemed applicable to the physical and chemical characteristics of K173 are as follows:

- Incineration
- Fuel substitution
- Solvent extraction
- Critical fluid extraction
- Pressure filtration
- Thermal drying of biological treatment sludge
- Thermal desorption
- Total recycle or reuse

Except for total waste recycle and reuse, all of the treatment methods listed above generate additional wastes in liquid or solid form. Such wastes would require additional

management, including additional treatment to meet applicable land disposal restriction treatment standards if necessary.

Incineration

Incineration is a destruction technology in which heat is transferred to the waste to destabilize chemical bonds and destroy hazardous organic constituents. Off-gases (following additional combustion in an afterburner) are fed to a scrubber system for cooling and for removal of entrained particles and acid gas. Three incineration technologies are applicable and demonstrated for organics in nonwastewaters: liquid injection, rotary kiln, and fluidized-bed. With the exception of liquid injection, incineration produces two residuals: scrubber water and ash. Only scrubber water is generated from liquid injection.

Fuel Substitution

Fuel substitution is a treatment technology in which heat is transferred to a waste to destabilize chemical bonds and destroy organic constituents. The process uses hazardous waste as fuel in industrial furnaces or boilers. The hazardous waste may be blended with other nonhazardous wastes and/or fossil fuels. It has been used in the treatment of industrial waste solvents, refinery wastes, synthetic fibers/petrochemical wastes, waste oils, and wastes produced during the manufacture of pharmaceuticals, pulp and paper, and pesticides. Fuel substitution generates two residuals: ash and scrubber water.

Solvent Extraction

Solvent extraction is a separation and recovery technology. The process removes organic constituents from a waste by mixing the waste with a solvent that preferentially dissolves and removes the constituents of concern from the waste. Wastes treated by this technology have a wide range of total organic content; selection of an appropriate solvent depends on the relative solubilities of the constituents to be removed and the other organic compounds in the waste. This

technology generates two residuals: a treated waste residual and an extract.

Critical Fluid Extraction

This is a separation and recovery technology in which a solvent is brought to its critical state (liquified gas) to extract organic constituents from a waste. The solvents used are usually gases at ambient conditions. The solvent is converted from a gas to a liquid via pressurization. As a liquid, the solvent dissolved the organic constituents and extracts them from the waste matrix. Once it is extracted the solvent is returned to its original gaseous state. The technology generates two residuals: a treated waste residual and an extract. The extract is usually recycled or treated by incineration.

Pressure Filtration

Pressure filtration, also known as sludge dewatering, is a separation and recovery technology used for wastes that contain high concentrations (greater than 1 percent) of suspended solids. It separates particles from a fluid/particle mixture by passing the fluid through a medium that permits the flow of the fluid but retains particles. Pressure filtration generates two residuals: dewatered sludge and water.

Thermal Drying

Thermal drying of biological treatment sludge is a destruction technology which uses controlled flame combustion or indirect heat transfer to elevate the temperature of the waste and, thereby volatilizes the organic constituents. Off-gas from the dryer is sent to an afterburner to complete combustion of the volatile component. This process generates two residuals: a treated waste residual and an extract.

Thermal Desorption

This is a separation and recovery technology in which direct or indirect heat exchange is used to volatilize organic constituents from wastes. Different from incineration, thermal desorption works by elevating the temperature of the organic constituents to effect a phase separation to a gaseous state without combustion. Thermal desorption units function by creating steam from the volatilization of the moisture in the waste from heating. The technology generates two residuals: a treated waste residual and an extract.

Total Recycle or Reuse

Total recycle or reuse within the same process or an external process eliminates waste generation and subsequently generates no treatment residuals requiring further management.

4.3.2 Applicable and Demonstrated Technologies for Treating Dioxins/Furans

In general, technologies applicable to the treatment of organic compounds are applicable to dioxin/furan compounds. These technologies are described in Section 4.3.1.

4.3.3 Applicable and Demonstrated Technologies for Treating Metals

Applicable treatment technologies for metals include those that immobilize or reduce the total amount of metal constituents in a waste. The technologies listed in this section are applicable and have been demonstrated to treat metal constituents in nonwastewater forms of other hazardous wastes. These technologies are commonly used to treat wastes which contain the metal constituents regulated by universal treatment standards. EPA (1994a) presents a thorough discussion of these technologies. The technologies applicable to the physical and chemical characteristics of K173 include:

- Stabilization
- Pyrometallurgical recovery process (high temperature metals recovery)
- Hydrometallurgical recovery processes
- Recycling

Stabilization

Stabilization is a broad class of treatment technologies that reduces the mobility of metal constituents in a waste; the metals are chemically bound into a solid matrix that resists leaching when water or a mild acid solution comes into contact with the waste material. Organic materials usually are not stabilized effectively and may, in fact, inhibit the stabilization of metals. Hence, stabilization is applicable to nonwastewaters only after the organics have been removed by other treatment.

Pyrometallurgical Recovery Processes (High Temperature Metals Recovery)

Pyrometallurgical recovery processes are those treatment technologies that use physical and chemical reactions at elevated temperatures for extraction/separation of metals, ores, salts, and other materials. For the purposes of the Land Disposal Restrictions Program, pyrometallurgical processes are referred to as High Temperature Metals Recovery (HTMR). Some examples of HTMR systems include rotary kilns, flame reactors, electric furnaces, plasma arc furnaces, slag reactors, and rotary hearth/electric furnaces. These thermal reduction processes use carbon, limestone, and silica (sand) as raw materials. The carbon acts as a reducing agent and reacts with metal oxides in a high temperature processing unit (e.g., kiln, furnace) to produce carbon dioxide and a free metal. This process yields a metal product for reuse and reduces the concentration of metals in the residuals.

Hydrometallurgical Recovery Processes

Hydrometallurgical recovery processes extract and recover materials by using acidic solutions. These processes are most effective with wastes containing high concentrations of metals that are soluble in a strong acid solution or that can be converted by reaction with a strong acid to a soluble form. Some hydrometallurgical processes include chemical precipitation, leaching, ion exchange, solvent extraction, and electrowinning.

EPA is aware that some facilities are using a series of technologies, including chemical precipitation, ion exchange, and electrowinning, to recover metals from various metal-bearing waste streams. Some of these facilities claim that these hydrometallurgical processes, unlike other processes, generate no residuals for land disposal.

Recycling

For some metal-bearing wastes, recycling may be an applicable technology. For example, nonwastewater forms of K061 wastes, such as electric arc furnace dust, may by recycled directly back into the electric furnaces from which they were originally produced. Such practices facilitate the recovery of metals in steelmaking while reducing or eliminating the material designated for land disposal.

4.3.4 Identification of BDAT for Nonwastewater Forms of K173

Organics and Dioxins/Furans

In its development of UTS, EPA identified incineration as BDAT for all constituents identified for treatment standard development for K173 (except for the hepta- and octa- dioxins and furans, where UTS were not established). EPA similarly expects BDAT to be incineration for the remaining hepta- and octa- dioxin and furan compounds, based on their similar structure to the other dioxin and furan constituents.

Metals

In its development of UTS, EPA identified two different BDATs for chromium and nickel. EPA identified stabilization as the BDAT for chromium and pyrometallurgical recovery process, also referred to as high temperature metals recovery (HTMR), for nickel. Stabilization, rather than HTMR, was chosen for chromium because the technology is demonstrated, commercially available, and achieves concentration levels believed by EPA to be routinely achieved by industry

for treatment of chromium-bearing wastes (EPA, 1994a).

Because metals cannot be destroyed there are limited treatment options for metals-bearing wastes (EPA, 1994a). EPA therefore believes that recovery is the best treatment option for metals, especially in cases of high waste metal concentrations. This technology is also matrix-independent (i.e., it consistently achieves the same levels of treatment performance regardless of influent matrix composition) and is involved in the following:

- Generally decreases the amount of material sent for land disposal;
- Recovers valuable resources; and
- Incorporates metals that are not recoverable into a stable slag matrix.

BDAT for Nonwastewater Forms of K173: Conclusion

EPA identifies incineration of BDAT for treating organic constituents in nonwastewater forms of K173 wastes. Depending on the concentration of metals present in the resulting wastes, additional treatment may be required. This additional treatment could include stabilization or HTMR.

4.3.5 Identification of Proposed Treatment Standards for Nonwastewater Forms of K173

EPA is proposing numerical treatment standards for all constituents identified for proposed treatment standard development. EPA is transferring UTS to the constituents selected for proposed regulation of nonwastewater forms of K173. Universal treatment standards have previously been promulgated for all but five of these constituents (i.e., hepta- and octa- dioxins and furans). For these five constituents, treatment standards have been calculated based on the existing UTS and detection limit data for other dioxin congeners. Details of the numerical treatment standard development for these compounds is presented in Appendix A.

Section 4.3.4 discusses the treatment train identified as BDAT for treating these constituents in nonwastewater forms of K173. EPA expects such a treatment train to result in treated waste with contaminant concentrations lower than the numerical treatment standards. If

the proposed numerical treatment levels are finalized for nonwastewater forms of K173, the use of any technology (other than impermissible dilution) would be allowed in complying with the treatment standards. Therefore, facilities are not required to use the above treatment train to manage nonwastewater forms of K173, and may find they can use an alternative treatment train to meet the proposed numerical treatment standards.

5.0 TREATMENT STANDARD DEVELOPMENT FOR K174

This section describes the treatment standards that EPA will propose to best meet the requirements of RCRA Section 3004(m) for wastewater and nonwastewater forms of K174. Because there is much overlap between the constituents selected for proposed LDR regulation in K173 and K174, much of the information discussed in Section 4 will be referenced rather than repeated.

5.1 Summary of Constituents Selected for Regulation

As presented in Section 3, proposed treatment standards are being developed for the following constituents in wastewater and nonwastewater forms of K174:

- 1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin (1,2,3,4,6,7,8-HpCDD)
- 1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)
- 1,2,3,4,7,8,9- Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)
- HxCDDs (All Hexachlorodibenzo-*p*-dioxins)
- HxCDFs (All Hexachlorodibenzofurans)
- *1,2,3,4,6,7,8,9*-Octachlorodibenzo-p-dioxin (OCDD)
- *1,2,3,4,6,7,8,9*-Octachlorodibenzofuran (OCDF)
- PeCDDs (All Pentachlorodibenzo-*p*-dioxins)
- PeCDFs (All Pentachlorodibenzofurans)
- TCDDs (All tetrachlorodi-benzo-*p*-dioxins)
- TCDFs (All tetrachlorodibenzofurans)
- Arsenic

These constituents represent two treatability groups: dioxin/furans and metals. Different treatment technologies are applicable for each category. Treatment technologies applicable to dioxins/furans were discussed in Section 4. Treatment technologies applicable to arsenic in wastewater and nonwastewater forms of wastes are discussed in Sections 5.2.1 and 5.3.1, respectively. Identification of BDAT for wastewater and nonwastewater forms of K173 are presented in Sections 5.2.2 and 5.3.2, respectively. Identification of treatment standards for wastewater and nonwastewater forms of K173 are presented in Sections 5.2.3 and 5.3.3, respectively.

5.2 Wastewater Forms of K174

5.2.1 Applicable and Demonstrated Technologies for Treating Arsenic

The treatment technologies described in Section 4 for metals in wastewater forms of waste are applicable to arsenic treatment as well. The concentration of metals (e.g., arsenic) is expected to be low so that the metals could be treated in conjunction with organics, without contributing to toxicity or other interferences.

5.2.2 Identification of BDAT for Wastewater Forms of K174

Although K174 wastes meet the definition of nonwastewaters as generated (40 CFR 268.2), EPA established treatment standards for both wastewater and nonwastewater forms of listed wastes to ensure that any waste streams that meet the definition of wastewater are also treated to meet appropriate treatment standards prior to land disposal.

The constituents requiring treatment in K174 wastewaters are dioxins/furans and arsenic. In developing universal treatment standards for dioxin/furan constituents, EPA identified biological treatment as BDAT (EPA, 1994c), as discussed in Section 4.

In developing UTS for arsenic, EPA identified lime conditioning followed by sedimentation and filtration as BDAT (EPA, 1994c). The UTS was developed from a full-scale process. Lime treatment followed by sedimentation and filtration is a common method to remove metals in industrial wastewater, such as wastewaters from electroplating operations.

To adequately treat both metals and organics potentially present in wastewater forms of K174, EPA identifies the treatment train consisting of lime treatment followed by sedimentation and filtration (for metals treatment), followed by biological treatment (for organics treatment) as BDAT for the treatment of wastewater forms of K174.

5.2.3 Identification of Proposed Treatment Standards for Wastewater Forms of K174

EPA is proposing numerical treatment standards for wastewater forms of K174. EPA is proposing to transfer universal treatment standards to the constituents selected for proposed regulation in K174. Universal treatment standards have previously been promulgated for all but five of these constituents (i.e., UTS are not available for 1,2,3,4,6,7,8-HpCDD; 1,2,3,4,6,7,8-HpCDF; 1,2,3,4,7,8,9-HpCDF; OCDD; and OCDF). The same treatment standard proposed for these five constituents in wastewater forms of K173 are proposed in wastewater forms of K174. Development of these treatment standards is presented in Appendix A.

5.3 Nonwastewater Forms of K174

5.3.1 Applicable and Demonstrated Technologies for Treating Arsenic

The treatment technologies described in Section 4 for metals in nonwastewater forms of waste are applicable to arsenic treatment as well. In addition, the technology of slag vitrification is also applicable to arsenic treatment. The vitrification process is demonstrated, commercially available, and achieves substantial treatment of arsenic. The vitrification process is capable of managing a wide variety of arsenic-bearing wastes. At the temperatures normally encountered in this process (1,100 to 1,400 °C), organoarsenic compounds will be combusted to arsenic oxide, carbon dioxide, and water. The arsenic oxide will react with the other glass-forming constituents present in the process, and become immobilized in the glass matrix.

5.3.2 Identification of BDAT for Nonwastewater Forms of K174

Slag vitrification was identified as BDAT for arsenic in developing the UTS. The vitrification process is capable of managing a wide variety of arsenic-bearing wastes. For dioxins and furans, incineration was identified as BDAT in nonwastewaters as discussed in Section 4.

For nonwastewater forms of K174, EPA has identified combustion as BDAT followed by treatment of the ash by slag vitrification. Such a treatment train would treat both organic and inorganic constituents.

5.3.3 Identification of Proposed Treatment Standards for Nonwastewater Forms of K174

EPA is proposing numerical treatment standards for nonwastewater forms of K174. EPA is proposing to transfer universal treatment standards to the constituents selected for proposed regulation in K174. Universal treatment standards have previously been promulgated for all but five of these constituents (i.e., UTS are not available for 1,2,3,4,6,7,8-HpCDD; 1,2,3,4,6,7,8-HpCDF; 1,2,3,4,7,8,9-HpCDF; OCDD; and OCDF). The same treatment standard proposed for these five constituents in nonwastewater forms of K173 are proposed in nonwastewater forms of K174. Development of these treatment standards is presented in Appendix A.

6.0 TREATMENT STANDARD DEVELOPMENT FOR K175

This section describes the treatment standards that EPA will propose to best meet the requirements of RCRA Section 3004(m) for wastewater and nonwastewater forms of K175. As presented in Section 3, proposed treatment standards are being developed for mercury in wastewater and nonwastewater forms of K175.

Treatment technologies applicable to mercury in wastewater and nonwastewater forms of wastes are discussed in Sections 6.1.1 and 6.2.1, respectively. Identification of BDAT for wastewater and nonwastewater forms of K175 are presented in Sections 6.1.2 and 6.2.2, respectively. Identification of treatment standards for wastewater and nonwastewater forms of K173 are presented in Sections 5.2.3 and 5.3.3, respectively.

6.1 Wastewater Forms of K175

6.1.1 Applicable and Demonstrated Technologies for Treating Mercury

Technologies applicable for treatment of mercury-containing wastes are those that reduce the concentration of mercury metals and/or reduce the leachability of these metals leaving behind a treated residual for land disposal. This section describes applicable and demonstrated treatment technologies for mercury removal from wastewater forms of K175. These technologies are based on EPA's *Final Best Demonstrated Available Technology (BDAT) Background Document for Mercury-Containing Wastes D009, K106, P065, P092, and U151* (1990), and include the following:

- Chemical precipitation and chemical reduction
- Chemical oxidation of organomercury constituents
- Carbon adsorption and ion exchange

Applicable technologies for the treatment in mercury also include some of those described in Section 4, including activated sludge, chemically assisted clarification, lime conditioning, sedimentation, filtration, and trickling filter treatment systems.

Chemical Precipitation and Chemical Reduction

EPA has identified chemical precipitation and chemical reduction, both followed by filtration, as applicable to treatment of mercury-containing wastewaters with high concentrations of inorganic mercury compounds. Chemical precipitation followed by filtration removes BDAT list metals and concentrates them in the wastewater treatment sludge. Chemical reduction (with reagents such as sodium borohydride) reduces mercury to the metallic state. The reduction step is then followed by filtration to remove mercury and other solids.

The applicability of chemical precipitation and chemical reduction technologies depends to some extent on the form of mercury in the waste (e.g., dissolved ionic, pure metal, and insoluble ionic). Mercury in the dissolved ionic form (soluble mercuric compounds, for example) may be reduced to the pure metal by the borohydride reduction process, while this process may not be effective in treatment of the insoluble mercury compounds. The borohydride process cannot remove the small amount of metallic mercury that is soluble in water. Chemical oxidation treatment may be required to oxidize metallic mercury to soluble ionic mercury prior to chemical precipitation treatment. The solids produced as a residual from chemical reduction processes are, in general, easier to treat by pyrometallurgical methods than are the solids produced in chemical precipitation treatment because they contain mercury in its elemental form rather than as mercuric salts.

Chemical precipitation (using sulfide) followed by filtration has been selected as BDAT for treatment of K071 wastewaters. Sulfide precipitation of mercury-containing wastewaters is widely used in the domestic chlor-alkali industry (EPA, Waste Specific Evaluation of RMERC Treatment Standard, 1998). It is also used by Borden Chemicals, the one facility identified as generating K175, for its treatment of mercury-containing wastewaters. In the treatment of other metals in wastewater forms of waste, discussed in Sections 4 and 5, lime is also used as a precipitation agent.

Chemical Oxidation of Organomercury Constituents

EPA has identified chemical oxidation followed by chemical precipitation and filtration as an applicable technology for wastewaters containing organomercury constituents. Chemical oxidation breaks the bonds between the mercury and the organic components of these constituents. Chemical precipitation then treats the mercury in the inorganic form. Chemical oxidation technologies are also demonstrated for treatment of wastewaters containing oxidizable inorganic constituents (such as cyanide or cyanate).

Carbon Adsorption and Ion Exchange

Two other technologies, carbon adsorption and ion exchange, are also applicable to treatment of wastewaters containing relatively low concentrations of dissolved mercury. The mercury must be in the soluble mercuric (Hg^{+2}) form in order to be removed by these technologies. Thus, these technologies may require pretreatment by chemical oxidation to solubilize any insoluble inorganic mercury. Carbon adsorption will also remove mercury from wastes containing dissolved organomercury compounds.

Carbon adsorption and ion exchange produce both a wastewater residual (from regeneration of the ion exchange resin or activated carbon bed) and a nonwastewater residual (the spent carbon or ion exchange resin, when these are exhausted and must be discarded). The waste regenerant solutions (usually acid solutions) are more concentrated than the originally treated waste. This waste usually is treated for mercury removal by chemical precipitation followed by filtration if these regenerant solutions are not recyclable to the process originally generating the waste. Spent carbon can be incinerated (if mercury emissions are controlled) or processed in a retort to recover residual mercury. The spent resins may also be processed by retorting to recover residual mercury.

Ion exchange is demonstrated (as of 1990) at many facilities in Europe for treatment of wastewaters generated from the mercury cell chlor-alkali process. Activated carbon adsorption is also used at several facilities for treatment of inorganic/organo mercury-containing wastewaters.

6.1.2 Identification of BDAT for Wastewater Forms of K175

In its development of UTS for wastewater forms of mercury, EPA identified lime conditioning followed by sedimentation and filtration as BDAT for treating mercury (EPA, Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards Volume B: Universal Standards for Wastewater Forms of Hazardous Wastes, 1994). This treatment train was used to calculate the universal treatment standard for mercury in wastewaters; 0.15 mg/L.

6.1.3 Identification of Proposed Treatment Standards for Wastewater Forms of K175

EPA is proposing numerical treatment standards for wastewater forms of K175. EPA is proposing to transfer the universal treatment standard for mercury for proposed regulation in K175.

6.2 Nonwastewater Forms of K175

Applicable treatment technologies and EPA's proposed treatment standard for K175 focuses on mercury treatment. Traditionally, EPA has promulgated technology-based treatment standards for the treatment of mercury in nonwastewater forms of hazardous wastes, when the mercury is present above 260 mg/kg. For example, 40 CFR 268.40 lists the treatment standard for organic-containing D009 as retorting or roasting (RMERC) or incineration in units operated in accordance with the technical operation requirements of 40 CFR Part 264, Subpart O and Part 265, Subpart O (IMERC).

The 1997 Mercury Study Report to Congress has identified sources that potentially release mercury to the air, as well as identifying subsequent human health and environmental effects from mercury in the environment. Pyrometallurgical processes, such as RMERC and incineration, are potential sources of airborne mercury in the environment. Additionally, EPA has published an advanced notice of proposed rulemaking (ANPRM) concerning alternative treatment technologies for mercury (with emphasis on nonwastewater forms of mercury); in the future, current land disposal restriction requirements for certain mercury-containing hazardous wastes may be changed. A principal reason for this re-examination is to investigate the environmental impacts of these technologies (64 *FR* 28949, May 28, 1999).

Recent events have heightened the Agency's awareness that the solubility of metals can be highly pH dependent and not adequately predicted by a single test. (See 63 FR 51225, September 24, 1998) Therefore, the Agency evaluated the mobility of mercury form this waste as a function of pH. Calculated solubilities of mercury sulfide (metacinnabar) as a function of pH have revealed that above pH 6.0 the presence of sulfide complexes results in significantly increased solubility.[4,5] Preliminary results from constant pH leaching measurements of the subject waste, as part of an on-going study, have shown similar results.[6] At pH 6.0 the waste tested leached 0.0058 mg/L. However, at pH 10, 1.63 mg/L mercury was solubilized. Current landfill disposal site conditions for this waste are reported to be pH 9.48-9.57.[7] Under these conditions, mercury in the waste would be expected to be mobilized especially if excess sulfides were present. Therefore, to avoid significant mobilization of the mercury present in the VCM-A waste disposal conditions also would need to be restricted to codisposal with materials less than pH 6.0.

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[4]H. Lawrence Clever, Susan A. Johnson, and M. Elizabeth Derrick, *The Solubility of Mercury and Some Sparingly Soluble Mercury Salts in Water and Aqueous Electrolyte Solutions*, J. Phys. Chem. Ref. Data, Vol. 14, No. 3, 1985, page 652.

[5]In Chemical Equilibrium (Bard, A.J., Harper and Row, Publishers, New York, 1966).

[6] Paul Bishop, Renee A. Rauche, Linda A. Rieser, Markram T. Suidan, and Jain Zhang; "Stabilization and Testing of Mercury Containing Wastes," Draft, Department of Civil and Environmental Engineering, University of Cincinnati, March 31, 1999. Please note that this is a draft EPA document not yet peer reviewed. Also, data within the report is still undergoing QA/QC review, and the text, data, and conclusions in the report may change before the document is finalized.

[7] May 14, 1999, landfill parameters, e-mail from Mitch Hahn, Waste Management.

6.2.1 Applicable and Demonstrated Technologies for Treating Mercury

EPA has identified the following technologies applicable for treatment of nonwastewaters containing mercury. These technologies are capable of treating wastes with high levels of organics and with mercury in sulfide form, which are characteristics of K175:

- Incineration
- Thermal mercury recovery processes
- Acid leaching process
- Stabilization.
- Chemical Oxidation

Descriptions of each of these technologies are, in general, obtained from EPA (1990).

Incineration

Incineration is applicable for treatment of nonwastewaters containing organomercury compounds or mercury in an organic waste matrix. Treatment using incineration technologies will destroy the organic constituents of the waste. As a consequence of destruction of the organics, incineration will break the organic-metal bond in the organometallic waste constituents. The metallic part of the organometallic constituents in the waste, as well as any metals present in a mixed metal/organic waste, will remain in the residual (ash) generated, will be removed from the gases exiting the incinerator by the air pollution control equipment, or will remain in the gases exiting the incineration system.

Thermal Mercury Recovery Processes

The RMERC treatment standard includes retorting or roasting in a thermal processing unit capable of volatilizing mercury and subsequently condensing the volatilized mercury for recovery (40 CFR 268.42). Thermal mercury recovery processes volatilize mercury from the waste at high temperatures and then condense and collect it as the pure metal, reducing the mercury concentration in the treatment residual compared to that in the untreated waste.

Retorting and roasting processes can be operated as batch processes in a closed vessel or continuously in a furnace. In retorting processes the waste is heated, the mercury is vaporized, and then it is collected in a condenser. The vessel is usually kept either at a slightly negative pressure or under a strong vacuum. Air is not introduced from outside the vessel. Roasting processes are usually operated continuously, but may be operated in batch. In roasting, air is supplied to the system as a source of oxygen to enable decomposition of some mercury compounds. EPA (1990) and EPA (1998) present further discussion of retorting and high-temperature metals recovery technologies.

Distillation technologies are applicable to treatment of wastes containing high concentrations of metallic mercury, such as U151. The residuals from distillation technologies are a high-purity mercury as the "overhead" product and the remaining solid residual referred to as the "bottoms."

As of 1998, several chlorine production facilities effectively manage their sulfide-containing K106 in onsite RMERC units. As a consequence, EPA considers retorting to be demonstrated for K106 and other sulfide-containing nonwastewaters such as K175. However, difficulties of mercury sulfide treatment were documented in the EPA "Waste Specific Evaluation of RMERC Treatment Standard" 1998 report and confirmed with recent (1999) EPA discussions with Bethlehem Apparatus, a commercial RMERC facility. Specifically, mercury sulfide is difficult to treat because elemental mercury condensed from the fuming process in mercury retorters easily recombines with the available sulfide ions. Additives are needed to prevent recombination, but this addition to the treatment train likely leads to an increase in waste treatment costs.

The presence of organic material may also cause difficulties for treatment (for example, the sludge contains 43 percent organic matter and an oil and grease content of 4 percent), as well as the presence of chloride (not measured in EPA record sampling, but likely present in the waste because the waste is generated from vinyl chloride production). Difficulties associated with the presence of chloride and organic chloride include the formation of impurities and acids in the

presence of steam that are corrosive to equipment. Further details are presented in the EPA "Waste Specific Evaluation of RMERC Treatment Standard" 1998 report.

Retorting is also demonstrated for treatment of nonsulfide-containing mercury nonwastewaters. U151 wastes and inorganic D009 wastes, such as mercury lamps, debris, contaminated equipment, and mercury cell batteries, are routinely treated by retorting, vacuum or scrap metal distillation.

Acid Leaching Process

Acid leaching solubilizes low concentrations of mercury in wastes, reducing the concentration of mercury in the nonwastewater treatment residual. The acid leaching process used for treatment of K071 wastes involves a chemical oxidation step followed by a step combining sludge dewatering and acid washing. This process generates an acid leachate (wastewater) that contains the mercury in soluble ionic form and requires treatment by chemical precipitation.

Acid leaching is demonstrated at chlor-alkali facilities generating K071 wastes. K071 wastes contain soluble mercuric chloride, insoluble mercuric oxide, and elemental mercury (EPA, 1988). This technology requires an additional step of oxidation to convert insoluble forms of mercury to the mercuric (+2) form, which is soluble. The soluble mercuric form can then be precipitated as sulfide salt.

Stabilization

Stabilization is applicable for treatment of nonwastewaters containing metals, including mercury, in an inorganic waste matrix. Stabilization treatment involves mixing the waste with a binding agent that is designed to reduce the leachability of metals from the waste.

In 1990, stabilization was identified as potentially applicable for treatment of (mercury

sulfide-containing) K106 nonwastewaters and possibly additional nonwastewaters. Stabilization typically binds BDAT list metals into a solid form that is more resistant to leaching than the metals in the untreated waste. EPA's testing of cement, kiln dust, and lime/fly ash stabilization for treatment of K106 nonwastewaters generated by sulfide precipitation indicates that the technology did not provide effective treatment. EPA believes the ineffectiveness of stabilization treatment of K106 in this EPA test may have resulted from the mercury sulfide behavior in alkaline media. Based on the available data, EPA has concluded that stabilization with alkaline materials may not be demonstrated for K106 wastes containing high concentrations of mercury sulfide. Other stabilizing agents, such as proprietary asphalt or silicate agents, may also be applicable, but data to enable such a determination have not been provided to EPA.

Chemical Oxidation of Organomercury Compounds

Chemical oxidation is applicable to the treatment of wastes containing organomercury constituents (such as phenyl mercuric acetate, P092). Chemical oxidation treatment of organomercury compounds involves addition of a chemical oxidizing agent such as chlorine, hypochlorite, permanganate, or ozone in an aqueous reaction medium. Chemical oxidation results in the breaking of the organic-mercury chemical bond, thereby generating a residual from which the organic contaminant can either be destroyed (by further oxidation or incineration) or recovered (by distillation). The inorganic mercury wastewaters resulting from chemical oxidation treatment can be treated by one of the technologies identified in Section 6.1.1 as applicable for wastewaters containing inorganic mercury compounds.

6.2.2 Identification of BDAT for Nonwastewater Forms of K175

EPA identifies roasting or retorting (RMERC) as BDAT for treatment of mercury in nonwastewater forms of K175. Mercury is typically present at high concentrations in this waste (based on data in Section 3). RMERC is expected to generate a residual with low concentrations of mercury (i.e., mercury concentrations in residuals generated by Bethlehem Apparatus range up to 30 mg/kg, based on EPA's 1998 RMERC report). Residues of RMERC may require

additional treatment to control leachability of mercury. Although incineration is applicable for organic-mercury wastes, this technology does not result in mercury recovery (without additional treatment) and therefore is not considered 'best.'

For K175 wastes with lower concentrations of mercury, EPA identified acid leaching as the BDAT for treatment of mercury in nonwastewater forms of K175. Acid leaching is a demonstrated technology that is commercially available and achieves substantial treatment of mercury in low-mercury subcategory wastes. EPA believes that the acid leaching performance data presented in representative of the "best" available treatment performance data for mercury in low-mercury subcategory wastes included in previous rulemakings (EPA, 1994b).

Consistent with EPA's recent activities and concerns regarding mercury in the environment, EPA is also considering a treatment standard for K175 consisting of stabilization. Consistent with the discussion presented in this section, EPA considers mercury sulfide stabilization 'best' when conducted at pH 6 or less, and when co-disposed with wastes of pH 6 or less.

6.2.3 Identification of Proposed Treatment Standards for Nonwastewater Forms of K175

EPA is proposing that mercury recovery by retorting or roasting (RMERC) be the required treatment technology for this waste, for wastes containing above 260 mg/kg mercury (total). For residues of the RMERC process, the current standard of 0.20 mg/L TCLP mercury is proposed. Consistent with its concern of mercury leaching at high pH, EPA is also proposing that the pH be no greater than 6.0 in these residues if the mercury is present in sulfide form.

For K175 wastes with lower concentrations of mercury (i.e., less than 260 mg/kg total), a numerical treatment standard of 0.025 mg/L (leachable mercury as measured by the TCLP) is proposed. Consistent with its concern of mercury leaching at high pH, EPA is also proposing that the pH be no greater than 6.0 if the mercury is present in sulfide form..

EPA is proposing an alternative treatment standard for comment. This standard would be a numerical concentration limit for all K175 wastes (i.e., regardless of total mercury content), equal to 0.025 mg/L mercury as measured by the TCLP. To ensure operational stability of the treatment process and proper long-term disposal, EPA proposes two conditions as part of this option. First, the waste residue generated, if in mercuric sulfide form, must itself be below pH 6.0. Second, if K175 wastes are to be co-disposed in a landfill with other wastes, co-disposal will be restricted to wastes with similar pH (i.e., not greater than 6.0). To comply with these requirements disposal facilities would be required to certify and maintain operating records available for inspection of codisposed wastes to demonstrate compliance.

7.0 REFERENCES

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EPA. 1998. Waste-Specific Evaluation of RMERC Treatment Standard. 1998.

EPA. 1996. Best Demonstrated Available Technology (BDAT) Background Document for Wood Preserving Wastes F032, F034, and F035. Office of Solid Waste, Washington, D.C.

EPA. 1994a. Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards, Volume A: Universal Standards for Nonwastewater Forms of Listed Hazardous Wastes. Office of Solid Waste.

EPA. 1994b. Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards: Volume B: Universal Standards for Wastewater Forms of Listed Hazardous Wastes. Office of Solid Waste.

EPA. 1990. Final Best Demonstrated Available Technology (BDAT) Background Document for Mercury-Containing Wastes D009, K106, P065, P092, and U151. Office of Solid Waste.

EPA. 1988. Final Best Demonstrated Available Technology (BDAT) Background Document for K071. August 1988.

APPENDIX A. NUMERICAL TREATMENT STANDARD DEVELOPMENT FOR HEPTA-/OCTA- DIOXINS AND FURANS

EPA has previously promulgated numerical treatment standards (i.e., universal treatment standards, or UTS) for all but five constituents proposed for inclusion in 40 CFR 268.40 for wastewater or nonwastewater forms of K173 to K175. These constituents, for which numerical treatment standards in K173 and K174 wastes are being proposed, are as follows:

- 1,2,3,4,6,7,8-heptachlorodibenzo-*p*-dioxin,
- 1,2,3,4,6,7,8-heptachlorodibenzofuran,
- 1,2,3,5,7,8,9-heptachlorodibenzofuran,
- 1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin (OCDD), and
- 1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF).

Currently, UTS are available for tetra-, penta-, and hexa- dioxin and furan isomers, expressed, for example, as all pentachlorodibenzo-*p*-dioxins (40 CFR 268.48). Setting treatment standards for only the above three hepta-isomers and two octa-isomers, rather than the classes of all hepta-dioxins and furans, would satisfy the requirements of RCRA 3004(m) to substantially reduce the toxicity of the waste. This is due to the following reasons:

- The three hepta-isomer and two octa-isomer compounds contain chlorine atoms in the 2, 3, 7, and 8 positions of the dibenzo-*p*-dioxin and dibenzofuran structures. As a result, they exhibit the co-planar structure of the congeners of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin and 2,3,7,8-tetrachlorodibenzofuran and therefore represent the most toxic compounds in the hepta-dioxin and furan series. Other dioxin and furan isomers with chlorine atoms substitutions, but not in the 2, 3, 7, and 8 positions are not as toxic as the above compounds.

- A waste treated to achieve treatment standards for these compounds is also likely to exhibit lower concentrations of the other hexa-dioxin and furan isomers, because the other isomers are likely to be affected similarly in treatment.

- These five compounds are proposed for inclusion in 40 CFR 261 Appendix VII as the basis for listing hazardous wastes K173 and K174.

Treatment Standard Development for Nonwastewaters

EPA has previously determined that BDAT for the tetra-, penta-, and hexa- dioxins and furans in nonwastewaters is incineration. See Table 4-1 in Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards: Volume A: Universal Standards for Nonwastewater Forms of Listed Hazardous Wastes, July 1994. EPA expects hazardous waste incineration to achieve at least 99.99 percent destruction of hazardous constituents such as dioxins and furans. In the Solvents and Dioxins Rule (i.e., Hazardous Waste Management System, Land Disposal Restrictions Final Rule, 51 FR 40572, November 7, 1986),

EPA determined that destruction of these dioxins and furans to below the detection limit available at the time (1 ppb) could be expected (51 FR 40615).

Quantitation limits for dioxins and furans using SW-846 Method 8280A are dependent on the target compound. For example, the quantitation limit for 2,3,7,8-TCDD in fly ash is given as 1.0 µg/kg. The quantitation limit of 1,2,3,4,6,7,8-HpCDD in fly ash is given as 2.5 µg/kg (quantitation limits for 1,2,3,4,6,7,8-HpCDF and 1,2,3,4,7,8,9-HpCDF are also given as 2.5 µg/kg in fly ash). The quantitation limits of OCDD and OCDF in fly ash are given as 5.0 µg/kg. To account for this difference in method performance, EPA is proposing a numerical treatment standard for these compounds which is higher than the existing UTS standard for TCDDs. EPA is therefore proposing a treatment standard of 0.0025 mg/kg for 1,2,3,4,6,7,8-heptachlorodibenzo-*p*-dioxin; 1,2,3,4,6,7,8-heptachlorodibenzofuran; and 1,2,3,5,7,8,9-heptachlorodibenzofuran. Similarly, for OCDD and OCDF, EPA is proposing a treatment standard of 0.0050 mg/kg.

A second basis for proposing the treatment standard of 0.0025 mg/kg and 0.0050 mg/kg for the above compounds is as follows. EPA estimates that quantitation limits would approximate the values of 2.8 times the method detection limits normally used to develop treatment standards from detection limit data. By definition the quantitation limit is 3 to 4 times the method detection limit.

Existing Treatment Data for Dioxins/Furans

EPA has no treatment data for HpCDDs, HpCDFs, or OCDF in nonwastewater forms of wastes using thermal processes; EPA has treatment data for OCDD in nonwastewater forms of wastes using thermal processes. EPA investigated the NRMRL data base [U.S. Environmental Protection Agency, National Risk Management Research Laboratory Treatability Database, Version 5, EPA/600/C-93/003a (1994)] for data demonstrating dioxin and furan removal using thermal processes. Treatment data were not available for incineration (the BDAT), however data were available for thermal destruction at pilot and full scale for dioxin and furan-containing wastes. Table A-1 summarizes these results. EPA expects incineration to achieve performance at least as effective as that shown here. Concentrations of tetrachlorodibenzo-*p*-dioxins and furans were reported as not detected in many of the samples, with a maximum detection limit of 38 ng/kg (38 ppt). When detected, the waste did not exceed concentrations of 16 ng/kg (16 ppt). For OCDD, concentrations in the soil residue were consistently detected, ranging from 2.4 to 23 ng/kg (up to 23 ppt). These data support EPA's conclusion that removal to 0.0025 mg/kg (2,500 ppt or 2,500 ng/kg) is feasible when using BDAT for HpCDDs and HpCDFs, and removal to 0.0050 mg/kg (5,000 ppt or 5,000 ng/kg) is also feasible when using BDAT for OCDDs and OCDFs. Further, the compounds can be quantified to this level in a matrix such as combustor or incinerator ash residue.

EPA did not use the treatment data for OCDD in calculating the proposed numerical treatment standard because the initial concentrations of the compound in the waste is much lower than levels expected to be present in K173 or K174 nonwastewaters. Specifically, concentrations of OCDD in nonwastewater forms of K174 range up to 6.48 ug/kg (6,480 ng/kg); see Table 3-2.

However, the OCDD treatment data in Table A-1 result from the treatment of soil with initial OCDD concentrations ranging from 640 to 1,200 ng/kg.

Since Method 8280A was first developed, the more sensitive high-resolution mass spectrometry Method 8290 has been developed. Method 8290 may achieve detection limits three orders of magnitude more sensitive than Method 8280A. However, EPA lacks actual treatment performance data for these wastes using Method 8290. Further, because of the trace levels of dioxins/furans that Method 8290 is capable of detecting, EPA has no assurance that treatment would achieve the much lower non-detectable levels of Method 8290. Therefore, numerical treatment standards are being proposed based on the more widely available Method 8280A.

Existing Data and Treatment Standard Development for Wastewaters

EPA has previously established UTS for dioxin and furan constituent classes in wastewater forms of hazardous wastes. The data used in developing these standards are described in Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards: Volume A: Universal Standards for Wastewater Forms of Listed Hazardous Wastes, July 1994. Treatment standards have been developed for the compounds presented in Table A-2. Table A-2 also presents the treatment data used in developing the standard, the source of the treatment data, and the resulting standard.

Treatment data for heptachlorodibenzo-*p*-dioxins were not available. Treatment data for heptachlorodibenzofurans were available using the treatment train of bench-scale dechlorination of toxics using an alkoxide formed by the reaction of potassium hydroxide with polyethylene glycol. Treatment data for OCDD were available using the technologies of activated sludge and sedimentation. Treatment data for OCDF were available using activated sludge, and the above mentioned dechlorination treatment train using potassium hydroxide and polyethylene glycol (NRMRL, 1994). These data are summarized in Table A-3.

EPA did not use any of the data in Table A-3 for treatment standard development. In regard to the dechlorination treatment train consisting of potassium hydroxide and polyethylene glycol treatment, EPA is not aware of any full scale process using this technology and thus did not use these data in developing numerical treatment standards. In regard to the remaining data based on available technologies of sedimentation and activated sludge, these data are from the treatment of domestic sewage, which may not represent the K173 and K174 wastewater matrices.

EPA expects that hepta- and octa-forms of dioxins and furans can be adequately treated using biological treatment, based on the data presented in Table A-2. Specifically, effluent concentrations of 0.0025 µg/L can be expected based on performance data for pentachlorodibenzofurans. A treatment standard of 0.035 µg/L was developed for pentachlorodibenzofurans based on these data[8]. EPA is therefore proposing a treatment standard

[8] U.S. Environmental Protection Agency. Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards: Volume B: Universal Standards for Wastewater Forms of Listed Hazardous Wastes. July 1994.

of 0.035 µg/L for 1,2,3,4,6,7,8-heptachlorodibenzo-*p*-dioxin; 1,2,3,4,6,7,8-heptachlorodibenzofuran; and 1,2,3,5,7,8,9-heptachlorodibenzofuran. For OCDD and OCDF , a treatment standard of 0.063 µg/L is proposed based on the performance of TCDDs. The Method 8280 quantitation limit for OCDD and OCDF is 0.050 µg/L, which is lower than the proposed standard.

Table A-1. Treatment Data for Dioxins and Furans in Soil Using Thermal Destruction

Final Concentration in Soil	Destruction, %
Tetrachlorodibenzo-*p*-Dioxins	
< 190 pg/hr	>99.9999
<38 ng/kg	>99.98
<360 pg/hr	>99.9999
<33 ng/kg	>99.98
<1.5 ng/kg	>99.995
<1.5 ng/kg	>99.997
<890 pg/kg	>99.998
<2.2 ng/kg	>99.995
<2.5 ng/kg	>99.996
Tetrachlorodibenzofurans	
<85 pg/kg	>99.8
13 ng/kg	97
16 ng/kg	97
6.7 ng/kg	99
11 ng/kg	99.1
Octachlorodibenzo-*p*-Dioxins	
2.4 ng/kg	99.7
4.4 ng/kg	99.3
19 ng/kg	97
23 ng/kg	97
12 ng/kg	99

Source: NRMRL, 1994. No other thermal treatment data are available for other dioxins and furans from this source.

Table A-2. Treatment Data for Dioxins and Furans (with Existing UTS) in Wastewaters

Constituent	BDAT	Treatment Data	Resulting Standard
Hexachlorodibenzo-*p*-dioxins	Biological Treatment	No data (transfer from TCDDs)	0.063 µg/L
Hexachlorodibenzofurans	Biological Treatment	No data (transfer from TCDDs)	0.063 µg/L
Pentachlorodibenzo-*p*-dioxins	Biological Treatment	No data (transfer from TCDDs)	0.063 µg/L
Pentachlorodibenzofurans	Biological Treatment	Average effluent concentration of 0.0025 µg/L. Based on 6 data points from industry-submitted data.	0.035 µg/L
Tetrachlorodibenzo-*p*-dioxins	Biological Treatment	Average effluent concentration of 0.0045 µg/L. Based on 6 data points from industry-submitted data.	0.063 µg/L
Tetrachlorodibenzofurans	Biological Treatment	No data (transfer from TCDDs)	0.063 µg/L

Source: Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards: Volume A: Universal Standards for Wastewater Forms of Listed Hazardous Wastes, July 1994.

Table A-3. Treatment Data for Hepta- and Octa- Dioxins and Furans in Wastewaters

Constituent	Description of Treatment	Effluent Concentration	Influent Concentration	% Removal
Heptachlorodibenzo-*p*-dioxins	No data			
Heptachlorodibenzofurans	Bench scale KPEG	<1.1 µg/L	>1 to 10 mg/L	>99.98
Octachlorodibenzo-*p*-dioxin	Full scale activated sludge (domestic sewage)	1.5 µg/L	0 to 100 µg/L	0
		0.45 µg/L	0 to 100 µg/L	63
		0.26 µg/L	0 to 100 µg/L	95.1
	Full scale sedimentation (domestic sewage)	0.08 µg/L	0 to 100 µg/L	99.5
Octachlorodibenzofuran	Full scale activated sludge (domestic sewage)	0.25 µg/L	0 to 100 µg/L	86
	Bench scale KPEG	<2.6 µg/L	>1 to 10 mg/L	>99.96

Source: NRMRL, 1994. KPEG: treatment train of bench-scale dechlorination of toxics using an alkoxide formed by the reaction of potassium hydroxide with polyethylene glycol.